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CENTENARY OF THE FARADAY EFFECT

EXACTLY a century ago, in November 1845, Faraday announced to the Royal Society the discovery of the phenomenon now known as the Faraday effect in his honour. The discovery was not made by accident but was the result of systematic experiments undertaken by Faraday in the hope of establishing a connexion between the phenomena of light and those of electromagnetism. His first attempts were to find whether an electrostatic field influenced the propagation of light through a material medium. As these experiments failed to yield an observable result, he was led to try the effect of a magnetic field. It was known at the time that a plate of glass under mechanical strain placed between crossed nicols gives a visible restoration of light. Hence, probably, Faraday was led to try a somewhat similar experimental arrangement in which an unstrained block of glass was placed between the poles of the electromagnet. A beam of light polarised by a nicol traverses the glass along the lines of magnetic force and then enters a second nicol which is set in the crossed position with respect to the first. In the absence of a magnetic field, the light transmitted in succession by the first nicol and by the block of glass is blocked by the second nicol. Faraday observed that when the electromagnet was excited, there was a visible restoration of light. That this was due to a rotation of the plane of polarisation of the light was shown by the fact that the light could again be quenched by a suitable rotation of the second nicol, the rotation necessary for this purpose increasing with the strength of the field and changing sign when the direction of the magnetic field was reversed. The magnitude of the effect depends greatly on the substance placed in the field. That Faraday succeeded in observing the phenomenon with the electromagnet of modest dimensions available to him was due to the fortunate circumstance that he used a block of special glass of high refractive index which he had himself manufactured in some earlier researches.

Faraday's discovery must have seemed strange and almost incomprehensible at the time to his contemporaries. In the fullness of time, however, it exercised a profound influence on the progress of physics. The phenomenon showed clearly enough that Faraday was right in thinking of electrical and magnetic actions as field phenomena and not as actions at a distance, as was then generally believed. Faraday's ideas, as is well-known, inspired Maxwell to develop his well-known theory of the electromagnetic field which indicated that light itself is an electro-magnetic wave-motion in space. Hertz's successful experiments of 1888 on the artificial production of electromagnetic waves were inspired in their turn by Maxwell's theory of which they were a confirmation. The identity of all forms of radiation in respect of their nature is now a commonplace of physics, but its recognition is nevertheless one of the greatest achievements of modern science, and it is well to emphasise that Faraday's discovery of his magneto-optic effect pointed the way to its establishment. Incidentally, it may be remarked that the Faraday effect has itself since been observed with electromagnetic radiations over a wide range of frequency. The rotation of the plane of polarisation of radio-waves in the upper layers of the earth's atmosphere by the action of the earth's magnetic field is now a well-established result. A similar phenomenon has also been demonstrated in the laboratory with short electric waves and a strong magnetic field, the necessary density of free electrons in the path of the waves being obtained by sending an electric discharge through a gas such as neon, argon or nitrogen at low pressure. The Faraday effect in the region of infra-red frequencies was observed very early in the history

of the subject. Curiously enough, its observation with ultra-violet radiation had to wait nearly half a century. More recently also, reports have appeared which indicate that the plane of polarisation of Rontgen rays is rotated in their passage through a thin sheet of iron placed in a magnetic field.

It is obvious that the presence of a magnetic field would have no effect on the passage of light through a transparent substance, unless the latter is itself capable of being magnetised by the field. This train of thought naturally induced Faraday to examine the question whether the block of glass used in his magneto-optic experiment was capable of magnetisation. Accordingly, he suspended the rod freely by means of a thread between the poles of the electromagnet and found to his astonishment that it set itself at right angles to the lines of magnetic force and not parallel to them as in the familiar case of an iron rod. This discovery naturally interested Faraday immensely, and he was so fully engaged in following it up that, as the story goes, he could not attend the meeting of the Royal Society at which his paper on the discovery of the magneto-optic effect was taken up for reading.

Most ordinary substances, both solid and liquid, which transmit light are diamagnetic like Faraday's block of glass. It is not surprising, therefore, that in practically all cases, the sense of the rotation of the plane of polarisation is the same, though the magnitude may be different in different substances. Even the so-called paramagnetic substances, which are attracted and not repelled by a magnetic field, show in most cases, rotation in the same sense as diamagnetic bodies. This is not surprising when we recall that diamagnetism is a universal property which must be assumed to exist, though in a suppressed form, even in paramagnetic substances. That the Faraday effect arises from the magnetisation of the medium is strikingly shown by the phenomenon (discovered by Kundt in 1884) of the rotation of the plane of polarisation of light in its passage through thin films of iron when placed in a magnetic field. The rotation in this case depends directly on the magnetisation of the film, reaching a saturation value at high field strengths, and altering with temperature in the same way as the magnetisation itself.

The observation of a special form of the Faraday effect characteristic of paramagnetic bodies was first made by J. Becquerel in 1906 and has recently received a great deal of attention. The distinction between the diamagnetic and the paramagnetic rotations arises in respect of the dependence of their magnitude on the temperature of the substance, the strength of the magnetic field and also its variation with the wavelength of the light. The most obvious difference between the two types of rotation is that the dispersion curve of the rotation is symmetric about a characteristic absorption frequency in the diamagnetic case and unsymmetric in the paramagnetic one.

The further question arises why, even granting the magnetisability of the medium, the propagation of light through it should be influenced by such magnetisation. It is clear enough that the answer to this question must be in the identity of the structures in the medium which are responsible alike for its magnetisability and for its influence on the propagation of light. Further, since the refractivity of a substance is connected with the possession by the substance of characteristic absorption and emission frequencies, it follows that the same structures must also be responsible for these latter properties. Thus, the successful observation of the Faraday effect involves as a necessary consequence that the characteristic emissions and absorptions of light by a substance would be influenced when the latter is placed in a magnetic field. It is on record that Faraday looked for such an effect but failed to find it. We may take it that the discovery of this phenomenon made by Zeeman in 1896 was prompted by the same train of ideas as that indicated above. Indeed, the magnetic behaviour of substances, the Faraday effect and the Zeeman effect are all intimately related to each other.

H. Becquerel in 1897 derived, from very simple considerations, a formula connecting the magnitude of the Faraday rotation with the field strength and the refractive dispersion of the medium for light of the particular frequency under consideration. Even according to the most recent theories, the diamagnetic part of the Faraday rotation in a medium composed of atoms is given exactly by Becquerel's formula. This is understood easily enough if we recall that a rotation of the plane of polarisation may be regarded as the result of a difference in the refractive index for left- and right-handed circularly polarised beams of light. In the absence of a magnetic field, the two indices would be identical. In the presence of the field, they would be different and the difference would be the same as that produced by a change of frequency of the light equal to twice the precession frequency of the electrons in the magnetic field given by the famous theorem of Larmor.

It is an interesting fact that the magnitude of the Faraday rotation in many ordinary substances (gas, liquid or solid) is given fairly accurately over the whole range of frequency of the visible spectrum and of the ultra-violet by the Becquerel formula. The observed rotation is, however, smaller than the calculated one by a constant numerical factor (less than unity) which may be called the magneto-optic anomaly of the substance. When we consider the complexity of the molecular structure of most ordinary substances, as also the complexity of their state of molecular aggregation, the appearance of such a simple numerical connection between the refractive dispersion and the Faraday rotation over a wide range of the spectrum must be considered very remarkable. Darwin and Watson, who in 1927 drew attention to the general validity of the Becquerel formula subject to this correction, remarked that while no anomaly greater than unity has been found and that while it is usually between 40 and 60 per cent., there did not appear to be any general principle governing the magnitude of the anomaly.

It is obvious that for real progress in the study of the Faraday effect, a satisfactory explanation of the magneto-optic anomaly referred to above is essential. We may regard the anomaly as a characteristic constant for the molecule, analogous to its optical anisotropy determined from studies on light scattering. A careful study of the figures given by Darwin and Watson shows that there is no direct or simple relationship between the magneto-optic anomaly and the optical anisotropy of a molecule. It is true that there are indications of such a connection, as for instance, in the fact that the constant is somewhat smaller for aromatic compounds than for aliphatic ones and is particularly small for substances such as carbon disulphide, nitrous oxide and nitrobenzene which show large depolarisations in light scattering. On the other hand, we have to consider the fact that the factor for carbon tetrachloride which is optically isotropic is 0·51, whereas for benzene which is highly anisotropic, it is 0·56. While, therefore, there is obviously no direct connection between the optical anisotropy and the magneto-optic anomaly of molelcules, the facts do not rule out a deeper connection in which the specific properties of the individual chemical bonds are involved. Long ago, in a remarkable series of investigations, W. H. Perkin showed that the magnetic rotatory power of organic compounds can be used as a powerful instrument for the study of their constitution. On the other hand, we also know that the optical anisotropy of a molecule is related both to its chemical constitution, and to its geometric configuration. The fuller elucidation of the relationship between these properties would obviously be a matter of great interest.

It is also now fairly certain that the Faraday effect can also be used with great success in the elucidation of the states of molecular aggregation. Here again, the problem centres round the explanation of the magneto-optic anomaly. Some progress has been made towards the solution of this problem in investigations undertaken recently at Bangalore. A fuller report of these investigations will appear in due course.

C. V. RAMAN.

SCIENTISTS' STUDY OF LAST SOLAR ECLIPSE

"Mass Attack" on Secrets of Radio-Wave Propagation

ACCORDING to a plan made by the Committee under Sir Edward Appleton, the British physicists and radio engineers co-operated in a series of observations lasting for seven days and centred on the day of the eclipse to obtain the effects of the last solar eclipse upon the upper and lower ionospheres. This particular eclipse afforded an unique opportunity for examination of the solar effects upon the ionosphere, because it occurred near about noon in summer when the lower ionospheric layers were highly ionised and the upper ones were clearly defined and separated one from the other.

It is well known that the formation of the ionized layers, upon which all long distance radio transmission depends has to do with the energy radiated from the sun. It is however, not yet fully known whether the ultra-violet sunlight is solely responsible for this ionisation. It may be that swiftly moving particles of matter from the sun towards the earth also contribute to the effect in some degree. If the latter phenomenon also contributes to the ionisation, the effect of the particles being cut-off by the moon in their path should be observed at a different time from the eclipse itself. The effects of the "corpuscular eclipse" and "optical eclipse" were, therefore, observed.

The normal equipment for measurement of signal intensity, equivalent height of the ionised layer, critical frequency, and maximum equivalent ionic density was arranged to be operated as far north as possible so as to be near the track of totality. In ultra short-wave case, the "Radar" equipment of war-time was employed in the detection of the ionisation responsible for the "bursts" as well as other abnormal patches in the lower ionosphere. Observations on American radio stations operating on very long wave-lengths were carried out by several organisations so that variation in their signal strength could yield information about the lower ionosphere. Observations on long and medium-wave stations in Scandinavia were taken to obtain the variation of radio-wave absorption during the eclipse and give information about the 'E' and 'D' layers. The short-waves came in for two classes of observations as follows:—(1) Stations in U.S.A., Canada, U.S.S.R. and South Africa were closely observed as to the variation in their signal strength during the eclipse and further information about "F," layer could thereby be obtained. The transmission paths of American and Russian stations passed near the track of totality while those of African stations remote from this served as a check upon the eclipse variations. (2) Stations in Norway and Sweden which were at shorter distances from Britain were observed for the variation in their signal strength.

The ultra short-wave stations were also observed for the "bursts" (sudden returns of energy from the upper regions lasting for a few seconds) to find out whether these were subject to a certain degree of solar control. Some observations were also made by direction-finding apparatus on stations laying far to the West, the East and the South of Britain to find out whether the incoming radio signals were diverted from their true great circle course due to the effect of the eclipse.

It is expected that the observations when analysed thoroughly will contribute greatly to the phenomenon of radio-wave propagation on all wave-lengths.

S. P. CHAKRAVARTI.

WANTED A MUSEUM OF EVOLUTION

INDIA is a country steeped in ignorance, with her population sinking in a morass of antiquated ideas and ancient superstitions. Reactionary forces under the garb of religion keep the people in a state of virtual civil war, and riots take place on the flimsiest pretexts. How can we prevent this internecine communal warfare? Various remedies have been suggested from time to time but without much success. This problem like others has many facets and should be attacked from many sides and all remedies suggested by intelligent people should be tried. The root-cause of the trouble appears to lie in people attaching too much importance to religion which to most of them means ritualism and recitation of incomprehensible verses from religious books. Only a sutdy of Biology can broaden people's minds, so that they may realize that primarily they belong to the species *Homo sapiens* and they are human beings first, and Hindus, Moslems and Sikhs afterwards.

Biology is a revolutionary science, which changes an individual's outlook on life as no other science does. There is a common misconception that Biology is merely a study of leaves and flowers of flowering plants, and of the bones of dead frogs and rabbits. A person who has never looked through the microscope at amœbæ and paramæcia wriggling and rolling at diatoms and desmids with their beautiful symmetrical shapes, the fine lace-like structure of the stem of a herb, and at the patterns of chromosomes in the dividing cell, may be excused for his ignorance. The microscope has revealed a new world, which is infinitely more beautiful and with such variety in shape and form that it surpasses all imagination. A layman who has not studied the mechanism of reproduction in plants cannot imagine that they too have sex, and some like ferns, Cycas and Ginkgo, have living motile sperms as in animals. In fact, a biologist looks at plants and animals with a different eye, and the vision of living beings, which he acquires by study and observation, greatly broadens his outlook on life and the universe. The study of heredity and evolution reveals an orderly universe, in which the whims and idiosyncrasies of gods and their miracle-working apostles have no place. A study of evolutionary Biology serves as a solvent of religions, dogmas, superstitions and misconceptions, which we so laboriously pile up in the primæval atmosphere of our Indian homes. It is only by a study of Biology that the so-called inherently religious Indian people will drop their religious blinkers and begin to see the world in the cold and clear light of science, liberated from the thraldom of superstition.

How can we bring the knowledge of Biology to the common man? I suggest that we should open "Museums of Evolution" in the public parks of all the university towns of India. At least we should make a start by opening such museums in centrally situated towns like Delhi and Allahabad. Parties of students should be invited from all the schools served by the university concerned and given lectures in Hindustani on the evolution of life and its significance, in these museums. A programme can be arranged on a provincial basis for all schools served by a particular museum, so that these institutions and their staff remain busy all the year round.

A "Museum of Evolution" is not a Natural History Museum in which all types of animals, dead or fossilized, are preserved. In a "Museum of Evolution" only those animals and plant types which have any evolutionary significance can find a place. It is a museum whose primary function is educational. In a "Museum of Evolution", the evolutionary history of 'Life' through the various geological epochs should be pictorially shown by means of mural paintings, charts, models and specimen of animals and plants of evolutionary importance. We can also show the process of evolution in the inorganic and organic world by means of models, *e.g.*, the evolution of atoms from electrons and protons, of molecules from atoms, and of colloids from molecules. The evolution of the planetary system from gaseous matter of a Nebula can also be shown by means of models.. Then we can show the progress of life through the ages from unicellular Algæ and Protozoa to Cœlenterates, Fishes, Ferns, Amphibia and Lycopods, Reptiles and Gymnosperms, and Mammals and flowering plants to Man and the present-day vegetation, by means of mural paintings, clay models and charts. The radiation of phyla of various plants and animals can be shown on a cone-like structure. Fossils of ancient plants and animals should also be shown, and in the case of rare missing links like *Archæopteryx* and fossil horses, plaster casts obtained from geological mueums of Europe and America can serve our purpose. We can also show the evolution of limbs, skeleton, ears, eyes, brain, heart, kidneys and sex organs from worms to Man by means of models.

A Portrait Gallery of Evolutionists

A separate room should be reserved for the portraits of eminent thinkers who have discovered the theories and facts of evolution and have militantly spread the idea in face of opposition from so-called religious people, Lamarck, Erasmus Darwin, Charles Darwin, Wallace, T. H. Huxley, Hæckel, Weissmann, Julian Huxley, and H. G. Wells, will inevitably find a place in such a portrait gallery of Evolutionists, and below their portraits, a gist of their works should be given for the benefit of the visitors. In such a Museum, a Library of all available books on Evolution should also be maintained, and pictorial cards and illustrated books on the subject of evolution should be sold to visitors at cheap prices. Bible societies provide free copies of Bibles to heathens when they visit the countries of the West, while on the other side, we see that no attempt has been made in this country to provide even cheap literature on a subject of such great importance as Evolution, which affects man's outlook on life so fundamentally. Cheap stereoscopic picture-books, fitted with the usual red and blue celluloid orthoscopes, showing various geological landscapes and forms of life prevalent in those periods, can be produced at democratic prices for sale to visitors. Cheap

picture-postcards of useful evolutionary charts, fossil animals and plants, and eminent evolutionists and biologists with brief descriptive notes should also be produced for sale to students and visitors at cost price. Films showing a reconstruction of evolutionary progress of life should also be shown in these museums. Walt Disney, in his *Fantasia*, has shown us a film which can be suitably modified for educational purposes. We should diffuse the knowledge of the theories and facts of Evolution among the masses thus rousing them from their age-long sleep. It we can get the services of mural painters like Diego Rivera and Orzoco, we should also venture into the facts of social evolution, showing the march of humanity from the primitive society of the Paleolithic period, through Pastoral, Agricultural stages, and Feudalism, Mercantilism, to Capitalism and ultimately to Socialism under the impact of Technology.

Such "Museums of Evolution" snould have a prominent place in our post-war educational programmes and plans. This is an age of visual education, and the plan of museums of Evolution with mural pictures, models and specimens, which we have outlined above, all serve as a better medium of instruction as compared with scores of schools and colleges. School teachers and students, who would come from all over the countryside to these museums, will become apostles of science and culture and will play an important role in educating India and in producing a generation of enlightened and cultured people, who will be able to hold their own in the vanguard of world progress.

M. S. RANDHAWA.

PROF. OTTO HAHN

PROFESSOR OTTO HAHN, who has been awarded the Nobel Prize in Chemistry for the year 1944, is a distinguished worker in the field of radioactivity. He has to his credit the discovery and isolation of several radioactive elements, as also the now well-known phenomenon of nuclear fission. Born on the 8th March 1879, he started his career as an organic chemist in an industrial concern and quitted this early to take up the study of the chemistry of the radioactive elements, being impressed by the outstanding work of Madame Curie and Rutherford. Working at first under Sir William Ramsay in the University College, London, he studied the activity of thorianite and isolated radio-thorium. In 1905, he proceeded to Montreal to work in Rutherford's laboratory and discovered radio-actinium. Returning to Berlin to work in the radioactivity section of the *Kaiser Wilhelm Institut Fur Chemie* (of which, later, he became the Director), he discovered mesothorium and perfected a method of separating radioactive products, using the recoil phenomenon. When he was elected to the Prussian Academy of Sciences in recognition of these researches and referred to his good fortune in working with men like Ramsay, Soddy and Rutherford, the President of the Academy naively remarked, "In science we very often find work without luck, but never luck without work". It will be interesting to recall that at a meeting in Bangalore some years ago to honour Sir C. V. Raman on his receiving the Nobel Prize, the Chairman, Prof. H. E. Watson, made a similar remark, "Accidents come to only those who look for accidents".

In the year 1918, in collaboration with Fraulein Lise Meitner, Otto Hahn discovered protoactinium, the immediate radioactive parent of actinium. They also came across the first example of nuclear isomerism in studies of the disintegration of uranium. With v. Baeyer and Meitner, Hahn showed by means of a magnetic analysis that the internal conversion electrons associated with gamma-rays always consist of perfectly homogeneous groups. When the idea of the possible existence of elements of atomic number higher than that of uranium was being put forward by Fermi, based on experiments on neutron-irradiated nuclear reactions carried out by him and his collaborators in Rome, Irene Curie and Savitch in Paris and Hahn and his co-workers in Berlin, set out to examine the products formed by the entry of the neutron into the uranium atomic nucleus, to confirm Fermi's conclusions. Actually, the searching chemical analyses of Hahn and Strassmann revealed that short-lived isotopes of barium and lanthanum are formed when neutrons bombard uranium. In announcing these unexpected results in the columns of *Naturwissenschaften* of 6th January 1939, they wrote with a certain amount of trepidation, "Perhaps, after all, our results have been rendered deceptive by a series of strange accidents". Soon after this announcement was made, Lise Meitner and Frisch pointed out in the columns of *Nature*, that the entry of the neutron into uranium brings about the disruption or "fission" of the nucleus, into two lighter fragments of nearly equal mass and charge, flying apart with great energy. Further chemical investigations in Hahn's laboratory showed that xenon and strontium were the final products in the break-up of the uranium nucleus. On the 23rd July 1939 Prof. Otto Hahn gave a talk on these researches at the Royal Institution in London, as a special guest of the Royal Society. Prof. Niels Bohr who attended this meeting, on his way back to Copenhagen from U.S.A., gave an account of his theory of nuclear fission, on the basis of the liquid drop model of the atomic nucleus, put forward by him, sometime earlier. A more elaborate theory of the mechanism of fission was given subsequently by Bohr and Wheeler in the *Physical Review*. Further experimental work by F. Joliot in Paris and Glasoe, Fermi and others in U.S.A., established the phenomenon of nuclear fission and indicated that it may be brought about in other heavier nuclei as well, by irradiation with neutrons or in some cases with gamma-rays. In conclusion, it may be recorded that the investigations of Hahn and his co-workers are unsurpassed in the assiduity with which they have been carried cut and the far-reaching developments they have led to.

C. K. SUNDARACHAR.
G. SURYAN.

RÖNTGEN RAYS, 1895-1945

By S. RAMA SWAMY, Ph.D., F.Inst.P.
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IT is fitting that on this occasion of the commemoration of their discovery half a century ago, we should refer to X-rays by the name of their discoverer, even though such a terminology is now obsolete. WILHELM KONRAD RÖNTGEN discovered X-rays while operating a discharge tube in his laboratory at Würtzburg in November 1895. For this discovery of fundamental importance in physics he was awarded the Rumford Medal of the Royal Society in 1896 and the first Nobel Prize in physics in 1901. This discovery opened the gates to a vast new field of fundamental scientific and industrial research and placed a new and powerful tool in the hands of the medical man for the alleviation of human suffering. The vastness of the field and the fundamental nature of the discovery may perhaps be best realised by the statement that during the fifty years following the discovery, as many as seven Nobel Prizes have been awarded for discoveries in X-ray physics. Eminent men of science have since worked in this field making outstanding discoveries of a fruitful character some of which have been of much use not only in physics but in other branches of science and industry. The discovery of X-rays was not a matter of chance. Röntgen was looking for invisible radiations emitted by a discharge tube. For this purpose, he had on his table a small screen of cardboard coated with crystals of barium platinocyanide such as those used at the time in Germany for revealing the invisible rays of the spectrum. Röntgen carefully covered up the discharge tube with black paper and excited it to find out whether all light was excluded. To his intense surprise he found the screen shining brightly. This led to further investigations and the ultimate discovery of invisible radiation from the tube, to which he gave the name X-rays "for brevity". These rays were found to be emitted by the spot on the discharge tube bombarded by the cathode rays. Röntgen conducted further experiments and discovered that X-rays traverse matter opaque to ordinary light and that they affect the photographic plate. He announced his discovery in a paper presented before the Physik-Medic. Gesellschaft of Würtzburg in December 1895. This paper was subsequently reprinted in *Annalen der Physik* (64, 1, 1898). In this very first paper he anticipated many of the different applications of X-rays which have developed during the past fifty years.

X-rays are emitted by any material bombarded by cathode particles. In X-ray tubes a metallic target, known as the anti-cathode, is provided for this purpose. In so-called gas tubes cathode-rays produced by the discharge are focussed on the anti-cathode by suitably shaping the cathode. In hot cathode tubes the electrons emitted by the hot filament of the cathode are accelerated by the applied tube voltage. They are also focussed on the anti-cathode by surrounding the filament by a concentric metal cylinder, one end of which projects a little beyond the filament. X-rays are emitted from the focal spot on the target. In gas tubes it is necessary to maintain a residual gas pressure of the order of about 10^{-3} mms. of mercury for running the discharge. The hot cathode type of tube is completely evacuated, degassed and sealed off. The tube voltage was generated by an induction coil in the early days. The high tension transformer is universally employed nowadays. During the past fifty years the application of X-rays in medicine, industry and scientific research has advanced very rapidly. Advance in the design and manufacture of X-ray apparatus has kept pace with the rapid advance in the application of X-rays. The range of apparatus commercially available is considerable, each type serving a specific purpose. X-ray tubes employing voltages of the order of millions are in regular use particularly in America. One such was developed by the Massachusetts Institute of Technology and is installed at the Huntington Memorial Hospital of the Harvard Medical School. Another one, thirty feet long and weighing ten tons, is in use in the Mozelle Sasson High Voltage X-ray Therapy Department of St. Bartholowew's Hospital, London.

The use of X-rays for diagnostic purposes in medicine was the first to be realised. Within a very short time of their discovery, they were successfully employed for diagnosing a diseased thigh bone in Paris, for observing the reunion of a fractured bone in Berlin and for the location of a bullet lodged in the calf of a patient in America. For diagnostic purposes, the X-ray shadow of the subject is observed on a fluorescent screen or alternatively photographed for obtaining a permanent record. Such a photograph is known as a radiogram, the technique itself being known as radiography. Radiography is a routine in many medical institutions nowadays. Bone and such other dense material throws deeper shadows than surrounding tissue so that the radiologist can, as it were, look inside the body of the patient.

Radiography is also in general use in industry, particularly in Europe and America. The detection of flaws in weldings, pressings, forgings and castings and also the inspection of assembled articles like radio valves, fuses and so on by radiographic methods is a matter of routine in many factories. This method is invaluable in the aircraft industry. Radiograms are often of great help to fine art for scrutinising works of art reputed to be ancient.

After the discovery of diffraction of X-rays by crystals in 1912 by Max von Laue, great advances were made on the investigation of the nature of X-rays on the one hand and the fine structure of matter on the other. Röntgen was of opinion that X-rays are waves due to *longitudinal vibrations* in the so-called luminiferous ether. Some physicists, mainly British,

thought that they were corpuscular like cathode-rays. But Laue's discovery definitely proved that X-rays are electromagnetic waves similar to light. Their wavelength lies in the range of about 0·06 to 500 Å. The work of Barkla, Mosley and others has shown that the X-rays emitted by the anti-cathode of an X-ray tube are of two types, *viz.*, the continuous radiation and the characteristic radiation. The continuous radiation consists of all wavelengths above a short-wave limit which itself is dependent on the voltage applied to the X-ray tube. The characteristic radiation consists of monochromatic radiation characteristic of the element of the anti-cathode. Every element has its own characteristic X-ray spectrum and X-ray spectroscopic methods have been developed for the analysis of any given material. Such methods led to the discovery of Hafnium by Hevesy and Coster in 1923. A systematic study of X-ray spectra has gone a long way towards the elucidation of atomic structure.

The diffraction of X-rays by crystals has led to the systematic study of the solid state of matter. The structures of a very large number of crystals have been determined resulting in the comprehension of many phenomena connected with the solid state of matter. Among outstanding workers in this field may be mentioned the late Sir William Bragg and his school.

X-ray crystallographic methods find a large number of applications in industry like the measurement of stress in castings, pressings and forgings. Many problems confronting the metallurgist like thermal equilibrium, internal stress and strain, crystal texture and phase identification may be solved by simple X-ray crystallographic methods. The development of these methods has advanced to such an extent as to warrant the organisation of Industrial X-ray Conferences by the Institute of Physics.

Systematic work on the biological effects of X-rays was stimulated by the discovery that continuous irradiation produces a disease known as X-ray dermatitis. X-ray irradiation in proper doses inhibits the growth of living cells in tumours. But prolonged exposures may produce proliferation of cells resulting in cancer. Some of the early X-ray workers became victims to such disastrous biological effects. Recommendations for adequate protection from such effects have been drawn up and published by the International Congress or Radiology. The biological effects are made use of in the treatment of certain types of tumours and skin diseases. X-ray irradiation is also known to produce mutations of chromosomes in certain cases.

Even from a casual survey of the past half a century of X-ray work, one cannot help finding that there are very few branches of human knowledge and experience which have not felt the impact of the developments of applications of X-rays. It is not too much to hope that their applications to the advancement of human knowledge and the alleviation of human suffering may multiply a thousandfold.

A LARGE-SCALE YIELD SURVEY ON COTTON

By V. G. PANSE,[1] R. J. KALAMKAR[2] and G. C. SHALIGRAM[1]

SINCE 1942-43 studies have been in progress on cotton for evolving a suitable method on a random sampling basis for forecasting and estimating the yield of the commercial crop. These have led to extensive developments, and not only has one large-scale survey on cotton been successfully carried out in the Central Provinces last year and another proceeding in the current season, but similar large-scale surveys on the principal food-crops, wheat and paddy, have been completed (Sukhatme, 1945) and are being conducted in different provinces by the Imperial Council of Agricultural Research. Within a short space of time, an efficient practical tool has thus been made available for measuring with precision the yield of crops covering millions of acres. The object of the present article is to describe the yield survey on cotton conducted during the season 1944-45 in Central Provinces and Berar. This survey, which has spread over 29,342 square miles and covered nearly three million acres of cotton, provided for the first time the means of estimating the average yield per acre and total production of cotton in the province by a scientific objective process.

For a proper appreciation of the sampling technique adopted, it will be useful to describe in broad terms the structure of a province in India. A revenue district is the major administrative unit in a province, and a province usually contains 20 to 25 districts. The geographical area of a district is about 3,000 sq. miles. A district is divided into four or five *tahsils* or *taluqs*, each with an area of 600 to 800 square miles and containing roughly 400 to 500 villages. A *tahsil* is further divided into three to five circles for the convenience of the revenue administration and a circle contains about a hundred villages. A Revenue Inspector is stationed in each circle. Communications between villages are poor. Good metal roads are few and far between and most of the villages are only accessible by a cart track. The revenue map of a *tahsil* with the village boundaries marked on it looks like a honey-comb with the villages forming the cells of this comb. The map of a single village reproduces the same pattern with individual fields forming the cells. Complete lists of villages in each *tahsil* or in each circle are available with the Land Records Department. The area of each field is accurately measured periodically and recorded in the villages. Except in provinces like Bengal and Bihar with a permanent land revenue settlement, there is a village accountant or *patwari* for each village or a group of villages and one of his principal

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duties is to make a complete seasonal enumeration of area under different crops by an inspection of fields within his jurisdiction. It is this unique feature of the land revenue administration in India which imparts to the figures for annual crop acreages in most provinces a degree of accuracy unequalled in any other country in the world.

Such a framework lends itself excellently to the application of stratified random sampling. The *tahsils* form relatively homogeneous and compact subdivisions of the tract to the surveyed, and villages and fields provide the principal and secondary sampling units. A strictly random selection of the sample villages within a *tahsil* can be made easily from the village list and a similar random selection of fields within a village also presents no difficulty as the list of all fields growing a particular crop in the selected village can be readily had from the *patwari*. The selected fields can be sample-harvested by locating one or more plots of a suitable size in random positions.

From two pilot surveys described earlier in this *Journal* (Panse and Kalamkar, 1944 *a*, *b*), the first carried out in Akola district in 1942-43 and the second in Akola and Buldana districts in 1943-44, it was found that if some 200 villages were sampled over the whole cotton tract of the province and four fields sample-harvested in each selected village, the provincial yield would be estimated with a standard error of 3 per cent. or less. This expectation as will be seen later, was borne out in the present survey. It was also found that the harvesting of a plot of 1/10 acre size, with which both the district land records staff and the farmers are familiar because of its adoption in the departmental crop cutting work, was quite satisfactory on the ground of practical convenience, as any change in plot size from 1·20 acre to 3/10 acre did not lead to a material change in the accuracy of the final yield estimates. It was, moreover, sufficient to harvest only one such plot per field as variation within a field was found to be quite small compared to the variability between fields.

The plot size may be made somewhat smaller in a tract where the yield level is higher; but very small plots, say 10 or 12 square feet in size, like those adopted by other workers (Hubback, 1927; Cochran, 1939; King and others, 1942) in surveys on cereals are obviously unsuitable for cotton where the harvest is gathered in five or six rounds of pickings spread over a period of three or four months. The use of such small plots in other crops also is beset with difficulties, both statistical and practical, from which the large plot is mostly free. In spite of its limitations the small plot seems to be adopted by workers in England and America on the grounds of convenience and economy; but it cannot necessarily claim the same advantage in India. The relationships between the availability and cost of field labour on the one hand and of transport and travelling facilities on the other are entirely different in the two cases.

The present survey included all four districts in Berar and three other districts, Nimar, Wardha and Nagpur, and three more *tahsils*, one each from the districts of Hoshangabad, Chanda, and Chindwara, from the rest of the province. It was carried out in 34 *tahsils* in all and sampled 99$^1/_4$ per cent. of the total cotton acreage in the province. A total of 204 villages were randomly selected in these 34 *tahsils*. In assigning the number of villages to each *tahsil*, two points need to be considered. The first is that the number of villages per *tahsil* should be in proportion to the cotton acreage in the *tahsil* in order to attain maximum accuracy in the provincial estimate of yield. Secondly, it is necessary to estimate the average yield of each district within a reasonable margin of error, as this yield figure is used administratively and forms the basis for calculating the normal or standard yield for the district. The latter condition requires that a certain minimum number of villages must be selected in each district irrespectve of its cotton acreage. As a comparison between these two considerations, the following scale was adopted for the selection of villages in the present survey.

Area under cotton in the tahsil	No. of villages selected per tahsil
Less than 50 thousand acres	4
50–120 ,,	6
120–130 ,,	8
above 139 ,,	9

A somewhat larger total number of villages than the number available in the present survey needs to be selected for a more satisfactory distribution according to the cotton acreage. The number in the present survey was restricted by the factor that the fieldwork was to be done by a wholetime temporary staff of fieldmen, each in charge of a group of three or four villages, and travelling between villages had to be kept down to a minimum.

In each village, four cotton fields were randomly selected and a plot of 1/10 acre (33 × 162′) was marked in a random position in each field and harvested. The produce was weighed by accurate iron beam balances and standard weights supplied to fieldmen, as the village balances and weights are unreliable, and the local weights, moreover, have widely varying connotations. The results of the survey are summarized in Table I.

The average yield per acre for the whole province was determined with a standard error of 2·9 per cent., and an error of this magnitude was predicted when the present survey was planned. The average yield per acre in different districts had a standard error ranging from 5 to 11 per cent. A somewhat higher standard of accuracy of the district estimates is clearly desirable, and the number of villages per district must be increased in future surveys, with a view to attain a standard error of the district estimates of yield as near to 5 per cent. as possible.

The official yield figure for the whole province was 192·6 lbs. of seed-cotton per acre

TABLE I
Yield per acre and total production in different districts

Name of district	Cotton area (thousand acres)	No. of villages selected	Yield of *kapas* (seed cotton) lbs. per acre	S.E. per cent of yield	Total production in bales of lint 1 bale=392 lbs. lint)
Buldana	469·1	30	194·6	7·8	79154
Akola	561·1	38	195·0	5·5	92810
Amraoti	552·1	33	143·6	8·6	65292
Yeotmal	511·8	39	207·2	5·4	89003
Total Berar block	2094·4	14	184·6	3·3	326359
Nimar	278·4	18	158·3	7·0	28556
Wardha	269·6	18	127·2	10·9	31272
Nagpur	108·0	16	123·6	10·8	11417
Harda (*tahsil*)	7·8	4	98·9	16·7	654
Warora (*tahsil*)	33·5	4	122·5	23·3	3251
Sausar (*tahsil*)	22·8	4	141·6	6·8	2816
Total C.P. block	675·4	64	141·3	5·4	77966
Whole province(C.P. and Berar)	2769·8	204	174·1	2·9	404225

according to the final forecast. It was 10·6 per cent. higher than the survey estimate, and the excess being more than twice the standard error of the survey estimate should be taken to be real. The excess in the separate blocks, Berar and C.P. was of the same order. The official overestimate has to be mainly attributed to a significant excess of 39·6 per cent. in Amraoti district and of 23·1 per cent. in Nimar district though the official figures were slightly higher than the survey estimates in most districts. It should be recalled that in 1943-44 when yield was much higher, and the survey estimates were 282 and 299 lbs. per acre in Akola and Buldana districts, the official figures were lower by 10 and 17 per cent. respectively. The tendency in the official forecasts to underestimate good crops and overestimate poor crops is well brought out by the survey results for the past three years.

The total production for each district and for the whole province is shown in terms of lint in the last column of Table I. Conversion of seed-cotton into lint involves the use of a factor for ginning outturn. The usual procedure is to adopt a conventional figure of $33^1/_3$ as ginning percentage. Its use, however, might introduce an error and possibly a bias in the estimated total production of lint, as the ginning percentage is known to vary according to the season and the variety of cotton. It was found, in the year 1943-44, for example, that the variety Jarilla (*G. arboreum* var. *neglectum*) ginned by the agricultural department gave a ginning outturn as high as $37^1/_2$ per cent. The rapid spread of this variety, which is growing in popularity, is bound to raise the average ginning outturn of the cotton tract in the province. For these reasons an attempt was made through the provincial department of industries to obtain ginning outturn data of the commercial crop of the season from owners and operators of ginning factories located in the cotton tract. Out of 82 factories addressed, apparently reliable information was secured from 61. From these data, ginning percentage values, appropriately weighed according to the quantity ginned and varieties, were calculated for almost every *tahsil* for conversion of seed-cotton production into that of lint. The ginning percentage values ranged from 29·7 to 34·9 in different *tahsils* and were generally higher where the variety Jarilla was dominant.

For the area covered by the survey the total production was thus estimated at 404,225 bales of lint as shown in Table I and this estimate is subject to a standard error of 11,456 bales. The area was, as stated earlier, $99^1/_4$ per cent. of the total cotton acreage. Extending the calculation to the full 100 per cent. area, the estimates of total production and its standard error were altered to 406,558 and 11,664 bales respectively. From the official estimates of the yield of *kapas* (seed-cotton) per acre and a ginning outturn of $33^1/_3$ per cent., the total production for the whole area was calculated at 456,681 bales or 12·3 per cent. must be counted to be in significant excess. If actual ginning percentages found from factory data were employed to convert the official yield figures for seed-cotton into lint, the official estimate for total production would be reduced to 449,148 bales and would then be higher than the survey estimate by 10·5 per cent., the excess still being significant.

Apart from its principal function of providing reliable yield estimates, the sampling survey can be utilized to obtain a considerable amount of ancillary information of great practical and scientific value. On certain topics, the survey is the only means of procuring representative data. A variety of useful data were collected in the course of the present experiment and are under examination. Space would not permit us to do more than make a brief reference to one or two items here.

The variety of cotton grown and its condition of purity were carefully observed in all selected fields, in order to assess the spread of improved varieties in the cotton tract. In this respect Berar was found to be in a distinctly better position than the rest of the province. Jarilla was practically the only variety grown in Buldana district, and in Akola district too, the varieties Jarilla and Verum (*G. arboreum* var. *neglectum*) accounted for nearly 90 per cent. of the fields. In Amraoti, besides Jarilla, 30 per cent. of its cotton area was under Buri (*G. hirsutum*), an improved American Upland variety. In the rest of the province, most of the area was found to grow unselected indigenous cotton (*G. arboreum* var. *neglectum*), ecepting Nimar district which had most of its area under improved varieties including 40 to 45 per cent. under Buri. This summary of the spread of improved seed has, however, to be qualified by the observation that a considerable degree of admixture was found in the fields. For example, only about 25 per cent. of the fields under Jarilla had a pure or a nearly pure crop of this variety. The Upland variety Buri was found to be purer in that about 65 per cent. of the fields with this variety were found free from admixture with indigenous plants.

Cotton is grown in the province mostly in mixture with other crops, chiefly *tur* (*Cajanus indicus*), the usual practice being to sow a few lines of *tur* at intervals among the cotton rows across the whole field. In calculating the net area under cotton an allowance is made for the areas occupied by these other crops. In Berar, the *patwari* directly records the net areas of cotton and of other crops in the field by eye appraisement while in the rest of the province numerical factors are prescribed for converting the gross area of cotton mixtures, which is recorded, into net area under cotton. To verify the soundness of this procedure and examine the accuracy of the allowance made for crops grown mixed with cotton, actual counts of rows of cotton and other crops were made in the fields selected for the survey. The analysis of these counts showed that the allowance made by the current procedure is substantially correct. No significant discrepancies were found in Berar, and in other districts also the conclusion was that only in areas on the periphery of the cotton tract, the extent of the mixture of other crops in cotton was probably underestimated.

The problem of improving yield forecasts from the standing crop is also being studied and eye estimates of the crop of the selected fields and quantitative observations on stand, number of bolls and boll weight, in small sample areas in the plot are recorded for comparison with the actual yield. The object is to determine how far eye appraisement alone can be relied on or whether it has to be supplemented or even replaced by quantitative observations. The possibility of a further improvement in the yield forecast made at the beginning of the harvesting season from a knowledge of the yield of the first picking is also being examined.

On the technical side, valuable information on the optimum number of samples and their distribution can be obtained from an analysis of the survey data. The methods employed for this purpose have been indicated in an earlier article (Panse and Kalamkar, 1944 *a*). The analysis of variance of the plot yields in the present survey showed that variability between villages was 1·56 times the variability between fields within villages in Berar districts, and 1·32 times in C.P. The two analyses were made separately because the variation both of fields and of villages was appreciably higher in Berar than in C.P. In the two previous seasons' surveys in Berar, the ratio of variation between villages and fields ranged from 1·4 to 1·8, and was thus of the same order as that observed in the present survey though the absolute variability of villages and fields differs appreciably in different seasons and in different tracts.

The number of villages and the number of fields per village required to be selected for securing yield estimates for the whole tract with a given degree of precision were calculated from the present results and are shown in Table II.

TABLE II

Number of villages and standard error of mean yield

No. of fields per village	No. of villages and standard error of mean yield					
	Berar results			C. P. results		
	1%s.e.	2%s.e.	3%s.e.	1%s.e	2%s.e.	3%s.e.
3	2216	554	246	1786	446	198
4	1825	456	203	1425	356	158

Previous surveys had yielded numbers of the same order of magnitude. The actual numbers obtained from different surveys would naturally differ to some extent both on account of real differences in variability and the sampling errors to which these numbers are subject. The present figures are found to have sampling errors of 15 and 18 per cent. in Berar and of 20 and 24 per cent. in C.P. It is rather clear from the three years' results that sampling on a scale sufficient to attain a standard error of 1 per cent. of the average yield is not a practical proposition in cotton. This low error can be reached in surveys on cereals (Sukhatme, 1945); but cotton is obviously more variable, and a standard error of 2 to 3 per cent. is all that can be aimed at. Experience in U.S.A. is similar (Sarle, 1932).

The ultimate goal of the present surveys is the introduction of the random sampling method as a permanent feature in the estimation of crop yields. The fieldwork of the surveys will have to be done by the existing departmental staff as the employment of any large permanent staff for this work alone seems out of question. Equipped with the technical experience of the past three years, we are now in a position to study the organizational phase of the problem, and this aspect has been given primary consideration in planning the provincial survey in C.P. and Berar for the current season. The temporary staff

of wholetime fieldmen employed previously has been dispensed with and the fieldwork is entrusted to the locally stationed district staff of the Land Records Department. For administrative convenience and a more even distribution of work, the revenue circle has been adopted as the unit for sampling in place of the *tahsil* though this change is not likely to lead to any further increase in statistical accuracy of the yield estimate. Two villages per circle where the cotton area is below 20,000 acres, and three for higher acreages is the scale of sampling adopted. This modification has resulted in the selection of a large number of villages, 335 against 204 in the last year, and made possible their distribution in proportion to the cotton acreage. The increase in the number of villages will be advantageous for both reasons. There are three fields under experiment in each village and the experiments in each circle are in charge of the Revenue Inspector of the circle. The supervising staff for each district also belongs to the department. The projected survey will be watched mainly to test the working efficiency of the organization, to detect its possible shortcomings and devise suitable remedies for these. With its conclusion the end of the experimental stage will be reached, and we may then expect with confidence that the provincial administrations will undertake yield surveys on this plan under technical direction as an annual routine.

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RIVER FLOOD CONTROL*

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Nature and Extent of the Problem

ALL over the world the problem of combating the destruction and damage caused by river floods is confronting the engineering profession. From the earliest times China has been affected by the floods of the Hoango and the Yangtse, as also our own mother-country, India, particularly parts of Bengal, Bihar and Orissa on the east, and the Indus Valley on the west coast. The Continent of America has figured largely during the last two centuries or so, where the engineers have been constantly at work during this period trying to tame the mighty Mississipi and other rivers. In the Continent of Europe flood protection works have been carried out during the last six or seven centuries, especially in Spain, France and Russia. In no country finality has yet been reached.

Fortunately, the State of Mysore, being situated on a plateau, is practically immune from inundations of rivers and consequent damages, though here and there are some towns which are affected to a small extent by floods. However, it behoves us as engineers to study this world-wide problem and keep ourselves abreast of the work that is being done by the engineering profession abroad. My object in reading this paper is thus to stimulate study and research by the members of this Association, some of whom may in future years be called upon to tackle flood protection works.

* Paper read before the Mysore Engineers' Association at their Conference held in 1945.

II. Collection of Essential Data

2. The first thing to be done in devising measures for river flood control is the collection of data under several heads, such as

(1) rainfall statistics in the catchments of the rivers extending from the head to the mouth for as many years as may be possible and for as many stations as are available;

(2) study of the topographical features of the catchment and the climatic conditions, and preparation of maps showing the areas affected by floods at different stages of the rivers;

(3) gauging of river flood discharges at vital reaches and correlating them to the rainfall and comparing them with calculated discharges based on river sections and slopes or with the recorded flow over weirs or at bridges;

(4) the extent and nature of damages caused from time to time, the population affected and the average annual loss caused to the people, the government, public utility companies, etc. This information has to be separately collected for urban and rural areas.

The study and collection of data should be a continuous one extending over several decades. This is especially so with regard to the calculation of flood discharges. It may be mentioned as an example that, in the case of the Mississipi river in America, a Special Commission was constituted by the Federal Government nearly four score years ago, and it has

been sitting since then collecting necessary data and carrying out measures for protection from time to time, but yet no complete protection has been afforded. Records of flood discharges show that anticipations made in the earlier years have been far exceeded by the actual flow in later years. It is stated by a certain authority that in the case of big rivers the highest floods occur once in a century or two or even at longer intervals. When data extending over longer periods are not available, some kind of forecast based on other similar rivers has to be made. After comparing discharges of the various rivers in the United States, one Mr. Weston Fuller has shown that the great floods of each river bear certain definite relations to the average annual floods on the respective streams. From these ratios he has deduced the following table showing the frequency of maximum floods of different magnitude:

Time in years	Ratio of maximum to average-hour flood-rate
5 ..	1·6
10 ..	1·80
25 ..	2·12
50 ..	2·36
100 ..	2·60
500 ..	3·16
1000 ..	3·40

These ratios cannot, however, be successfully applied until the average can be determined fairly approximately and they should be used only to supplement the local data.

III. Causes of Floods

3. The causes of floods and the factors affecting the intensity of floods have to be found before suitable remedies can be applied. Flood discharges vary a great deal, depending upon the intensity and duration of rainfall, the size, shape, topography and the geology of the catchment, the extent and nature of forest growth, climatic conditions of the region, etc. Floods of great rivers are caused by general heavy rains of considerable duration and also, more or less, by a series of local storms. If a watershed is long and narrow, it may have a less rate of flood run-off than if the catchments were circular or fanwise. Basins with very gentle slope serve more or less as detention reservoirs, while those with steep slopes bring about rapid floods. When slopes are gentle and the rainfall is of low intensity, the rain water is absorbed by the soil to a larger extent than otherwise; when the soil is of sandy and gravelly nature the percentage of absorption is still greater. Surface vegetation is also another factor moderating the intensity of run-off. The existence of natural lakes and ponds brings about greater uniformity of flow and reduction of the peak floods. Though afforestation or deforestation may not affect floods very materially, the former reduces the rate of run-off, while the latter tends to increase it.

The discharges derived from rainfall records have to be verified by actual river gaugings at selected reaches. A hydrograph showing the daily flow throughout the year and extending over a number of years will be found of great use. A proper block survey of the tracts affected by floods should be made and the areas actually flooded at different stages of the river above the bank-ful stage clearly indicated on the maps.

Inundation of marginal lands is caused by the river flow over-topping the banks on account of the undue silting of the river-beds, which, in deltaic country, are found to be higher than the marginal lands. The raising of the river bed has often been the result of sufficient waterway not being available in the river to carry the heaviest floods which thus spill over the banks. There is a definite relation between the quantity of water flowing in, and the silt conveyed by, a river. If the volume of flow is reduced by spilling, the silt is deposited on the bed resulting in the rise of the bed level. The waterway being thereby reduced further, succeeding high floods have necessarily to spill over the banks more and more and the tendency for the bed to silt up increases from year to year. The marginal lands are scoured by the floods spilling over and their level gets gradually lowered and subsidiary river valleys deeper than the original river are thus formed. This is how in deltaic regions the main rivers are generally found to be higher than the marginal countryside and a number of new rivers are formed—lower than the original river, which may die out in the course of centuries.

It is thus obvious that, in a system of works designed to prevent damages by floods, wherever possible, the original river should be made to function. Levees will be of use in making the rivers carry more water and silt than they can without such aid and clear their own beds. The quantity of silt carried by a main river will not be transported in full when it breaks up into two or more branches. Such breaking up should be prevented if the main rivers should remain in an efficient condition.

Sometimes it is found that floods are caused by encroachments on the natural waterway of rivers by structures artificially raised in towns and cities, authorisedly or unauthorisedly, or by railway and road embankments and such other works interfering with the river courses. It is most desirable that when any flood protection work is undertaken, a system of control on the construction of buildings, towns, factories, or other structures, etc., along river banks should be effectively enforced. Without such control it will soon be found that protection afforded at heavy cost will be nullified by unauthorised encroachments.

IV. Measures for Protection

5. When full data have thus been collected measures for protection can be designed. These measures may be grouped under three heads:

(1) Flood prevention,
(2) Flood diversion and
(3) Flood protection.

Under the first head will fall reservoirs and detention basins, afforestation, etc.

Flood diversion involves temporary or permanent diversion of peak floods from places along rivers where harm is likely to result to other places where a flood is less objectionable or to a valley which can carry the extra floods safely.

Under the third head are included levees, river channel improvements, such as, cut-offs, enlargements, etc.

It has been found by long experience in America and elsewhere that no single method can give hundred per cent. protection against floods. A thorough examination of every possible method of solution has to be made and conclusions reached after a full consideration of all the factors. The question in each case will be, not which method to apply, but how much of each will be most advantageous.

A study of practical measures adopted in many countries brings out the fact that there is a place for all remedies above mentioned. It may be generally stated that the best measure is the one that involves the least initial cost, reasonably low working expenses and that which most nearly fits in with popular ideas.

The expenditure involved should bear a reasonable proportion to the losses to be averted and the benefits to be secured. If the protection of big cities and industrial areas are involved, half-way measures will not do. The protection against floods must in their case be absolute and certain. If, however, only agricultural interests are to be protected, the aim should be more to prevent loss of life, both of men and animals, and serious damage to crops. In this case it may not be necessary to avoid flooding of agricultural lands altogether, as a certain amount of flooding of crops will not result in their total destruction, while there may be some advantage gained by partial flooding. The remedy need not, therefore, aim at complete protection, as in the case of cities and industrial areas, but only partial relief. The success of such protection has to be tested by the rapidity with which the farmers can rehabilitate themselves after an occasional crop loss.

Thus, after a full preliminary investigation of the several methods, it would be possible to eliminate or defer some of the more costly alternatives and confine detailed investigations to the cheaper remedies and save time and money.

6. I shall now offer a few brief remarks on each of the methods referred to above.

(*b*) *Flood Prevention.*—Storage reservoirs and what are called detention basins, afforestation, ground water storage and such like measures are included under this head. Storage dams, if built of the required capacity, have no doubt, the effect of moderating floods, *i.e.*, reducing the heights of extraordinary maximum floods. If reservoirs are to be effective against such floods, they must be kept empty in order that high floods may be absorbed at any time during the season in which such floods are expected. But if a reservoir is to be constructed for flood protection alone it will not be an economical proposition. It has, therefore, been usual with such schemes to combine generation of hydro-electric power or to improve the means of navigation along the rivers or to supply water for irrigation, for industrial purposes or city water supplies. Though these purposes are somewhat antagonistic to those of flood protection, if all these purposes are borne in mind when designing and sufficient capacity allowed for every one of the objects aimed at, a reservoir may be practicable. The design should be absolutely secure against any possibility of failure, as any such failure will result in a more disastrous flood than the one which the reservoir is intended to prevent. The situation of the dams has to be carefully selected, not merely with reference to its engineering and geological features, but also with reference to its distance from the flood-affected areas. Head water reservoirs will for example be of little use if the lowest reaches of the river are to be protected.

Detention basins are based on the principle of interpolating a high dam across a river with some openings in the structure constantly functioning. The idea of constant functioning is that the action will be automatic depending on nobody's discretion. Such basins are used in France. The effect of these basins is to retard the flow by partial absorption of high floods and to bring down the maximum to safe limits.

Ground water storage is secured by forming terraces in the catchment area and also by raising cover-crops which absorb rainfall to a certain extent, both of which will thus reduce the ratio of run-off. It is stated that these two methods have been adopted in the Tennessee Valley in America and they are found to absorb about four inches run-off on the catchment, proving a valuable supplement to storage by dams, the main means of control.

Coming now to the effect of forests on rainfall, I may say that there are conflicting views, one holding that forests act as equalisers of the flow of streams by diminishing in general the frequency of freshets and increasing the water flow in the non-rainy months. The other school holds that forests are of little or no benefit at all in respect of either. Such extreme views have to be avoided. There can be no doubt that the existence of forests will have a restraining effect upon run-off, ensure better regularity of flow in the high flood season and increase the summer flow. They also prevent erosion of steep mountain sides. The prevention of erosion is an important factor in any system of flood protection as erosion will result in undue silting of river beds, which is one of the main causes of destructive floods. The conservation of forest growth is, therefore, as necessary as any other measure of protection.

7. (*c*) *Flood Diversion.*—This method aims, as already stated, at temporary or permanent diversion of floods from places where damage is likely to result to less objectionable places. The diversions are effected by high level escape channels whether controlled or uncontrolled. The quantity of floods to be diverted has to be based on the carrying capacity of the river channel lower down and the safe pre-determined capacity of the escape channel. The head of the diversion channel should generally be located on the convex side of the stream and the velocity throughout the

channel must exceed the velocity in the section of the stream immediately opposite the diversion channel.

When not prohibitively costly, regulators should be provided to control the flow either through the diversion channel or the original river channel to the desirable or necessary extent.

Where the existing mouths of rivers are following a tortuous course or are blocked by bars, diversion is effected by opening fresh direct outlets to the sea. In such cases care should be taken to see that sea-water does not flow back along the river and flood culturable lands with salt water and make them unfit for cultivation.

IV. (*d*) Flood Protection

8. The most popular and common method of protection against floods is *by means of levees or embankments.* This system has been extensively used in America. It has also been in vogue in India in several of the river deltas in Madras, Orissa and parts of Bengal. The construction of these embankments is generally attended with difficulties as they have to be formed by the soil obtained near about the river banks, which consists mostly of sand and silt. The material being porous the banks get saturated in high floods and slips may occur. They have, therefore, to be made broad enough and the slopes sufficiently flat and turfed or otherwise protected and maintained carefully. Percolation drains will have also to be provided. The heights of these levees are generally limited to about 20 or 30 feet.

The natural banks of rivers are subject to scouring action by the moving currents of water, and the artificial embankments are thereby endangered. In such places the banks have to be protected by stone revetment or, as in modern days, by flexible concrete mats. It may be found that this method may often be more costly than constructing new levees by retiring them to safer areas beyond the river margins. In towns and cities, however, such shifting may not be possible as acquisition of properties will be very costly.

Retired embankments are also provided when adequate waterway cannot be secured otherwise.

9. At one stage the Mississipi River Commission considered that the only safe solution for flood protection was by levees. But later experience has shown that they have not afforded the extent of safety desired or necessary and reservoirs have been found to be quite necessary along with other measures, such as diversion by means of spillways. The chief objection urged against levees is that when they fail they cause much greater damage than the natural river would have done by flooding marginal lands. This difficulty, however, is common to other remedies also, and on that ground the levees cannot be ruled out. At any rate all over they have taken precedence over other measures of relief, and have been more extensively used than any other means . Care should be taken in designing them properly with reference to foundations, nature of soil available for formation, duration and stage of high floods, the margin of free board to be allowed in the case of agricultural lands or in city limits, etc. When proper precautions are thus taken for making levees substantial and strong, failures can be minimised.

In city and urban areas masonry walls are generally built as they occupy less area than the earthen embankments and involve also less risk.

IV. (*e*) River Channel Improvements

10. I now pass on to river channel improvements which are generally combined with levees. Improvements are effected by increasing the sectional area of the rivers either by deepening or widening or by both and straightening river channels. Bends are eliminated by cut-offs and the channel surface is smoothened by removing obstructions. In carrying out the above measures the energy of the flowing waters during floods should be made use of to the maximum possible extent for clearing the dredged material or excavated spoil or enlarging pilot channels and such other processes.

At places where rivers divide themselves into branches the currents should be so guided that each branch takes its due share of the flowing water and of the proportionate sand burden. Regulators may be necessary at the forks and provided when cost can be afforded.

IV. (*f*) Model Experiments

11. It is very desirable that model experiments should be conducted at special Research Stations and the effect of each kind of remedy tested. This is necessary because the effect of some of the improvements has been found in many cases to be very temporary. For example, dredging of hard spots proves effective for some time, but after a few years it is found that the silt and sand brought down from the higher reaches accumulate at the very place and soon make up a simliar obstruction. The same is the case with cut-offs. Unless the surface fall of the flowing waters is increased right from the point of the first cut-off down to the mouth, the effect of individual cut-offs will be found to be local. This is due to the fact that while the flow line level above the cut-off is increased in slope, that below is reduced, unless the next cut-off downstream and the next and so on are tackled in series. The study, therefore, by means of experiments will demonstrate the success or other of the remedies proposed. The cost of such experiments will be a trifle compared to the advantages they secure.

IV. (*g*) Flood Warnings

12. In modern systems of flood control, warnings are given to the people in advance by means of telephones, radios and telegrams. Radio sets will be found very useful during floods as even telegraph or telephone communications are liable to fail during heavy storms.

IV. (*h*) Aerial Cloud Streams

13. In the *Scientific American* of October 1938, a remarkable phenomenon was alluded to in an article by one Mr. Alexander Maxwell. It would appear that, just as is the case with ocean currents, there are aerial currents which appear like meandering clouds. These air currents instead of evenly distributing rain-

fall get concentrated in some restricted area or other, causing very high floods there. These aerial streams, it would appear, "snake and twist" like giant firehoses and change their course from one ocean to the other, say from the Atlantic to the Pacific. There is, however, one factor of safety as unlike earthquakes or tornedoes which come without notice, these streams appear, it is said, several days in advance of their discharging the burden and it is, therefore, possible to predict the appearance of a phenomenal flood. Though at a short notice of a week or a few days it may not be possible to devise effective protection works, it would be easy for the people to get out of the way of a flood in advance and save themselves and their property.

V. Financial Responsibility and Advisory Board of River Control

14. The works of flood protection are to be permanent ones, benefiting the future as well as the present generation. There must be, therefore, no undue burden thrown on a single generation. The works should be spread over many years and, as actual experience is gained from time to time, the nature of remedies should be developed by stages. The cost of protection works has no doubt to bear a certain proportion to the value of ascertained damages to be averted. When the local population is likely to derive benefit from the betterment of their property they will have to bear some part of the expenditure incurred.

In America the Federal Government has been financing protection works on big rivers like the Mississipi traversing many States. Individual States will not be able to finance costly works and it is but right that the Central Government should bear the burden.

The case is even stronger in India, where the Provincial finances are generally too slender to meet such liabilities. The Central Government should come to the aid of the local Governments even in cases where only one Province is involved as in the case of the Mahanadi delta in Orissa, and more so when more than one Province is concerned.

It would be indeed desirable, considering the huge interests involved, that the Government of India form an Advisory *Board of River Control* for the whole of India to examine all major schemes of flood protection and advise them as to the extent of financial help that may be rendered in each case.

VI. Conclusion

15. I have endeavoured to give in the foregoing pages an outline of the causes of destructive river floods and the remedial measures generally adopted for protecting life and property. It is not possible in the course of a paper of this kind to deal exhaustively with the various methods. Each area to be protected will have its own peculiarities and remedies will have to be adjusted to local causes and conditions. There can be no uniformity of method applicable to every case. Patient study and research extending over many decades will be needed for protecting large extents like the deltas of big rivers in India.

A careful examination of the flood problems will reveal that every kind of remedy has its place somewhere. "It is by a knowledge of the fundamental principles and ingenuity in their application that flood problems could be solved with assurance that the works would be economical and effective."

Note.—The cost of printing this article has been met from a generous grant-in-aid from the Imperial Council of Agricultual Research, New Delni.

PROPOSAL FOR WORLD UNIVERSITY

A Proposal for an International University from which lectures could be broadcast to students in their homes all over the world is to be discussed at the United Nations Education Conference in London. The idea has been sponsored by Professor Mikolaj Olekiewicz, teacher of Mathematical Statistics at the newly founded University of Lublin and one of the Polish delegates to the Conference.

Professor Olekiewicz, a fugitive from Germany during the occupation, believes that an International University would provide a practical answer to many problems in Europe where text-books had been burnt, schools destroyed and teachers killed. But he would at the same time like to see the University made permanent.

He adds: "My concept of the Faculty is this—prominent men of science, art and letters will be appointed from all countries of the United Nations. These men could deliver their lectures in their own studies merely by hooking up to the University's network. There would be no resident students. Young men and women all over the world could listen in their homes and at the same time enrol in correspondence courses conducted by the University. Once or twice yearly, students of the University should be given an opportunity of meeting other students—it would be fairly easy to arrange that."

BAT RADAR

By JOHN ERIC HILL

(Drawing by G. Frederick Mason)

IN the post-war world, pilots of commercial airplanes will have radio instruments that will determine accurately the position of obstacles and their distances from the plane, as well as the altitude of flight and the physical conformation of the surface of the earth below. These radio detection devices, or radar instruments, function as well in fog and bad weather as they do in clear weather.

The public has been given enough information on radar to understand the general principles involved: Radio impulses are beamed out into space, and when any solid object is encountered, an "echo" rebounds. This echo is received by a detector which indicates the direction from which it comes and the time required for its return. . Since radio impulses travel with the speed of light, approfflimately

327 yards per microsecond (a millionth of a second), it is possible to compute accurately the distance the beam has travelled, half of which is the distance of the object.

Bats, the only mammals that can truly fly, use a similar method for avoiding obstacles in their darting flight. Instead of radio impulses, they emit a series of intense cries, pitched too high to be heard by the human ear, and they are guided by the echoes that their sensitive ears are tuned to hear. For generations, the ability of bats to make their way through the inky darkness of winding caves puzzled naturalists. More than 150 years ago an Italian scientist blinded bats and found they could fly as skillfully as ever. While their sight is far keener than usually believed ("blind as a bat" is one of our false proverbial sayings), these experiments proved that they did not depend on their eyes. Some years later an investigator found that if the ears were plugged, the flying skill of a bat was greatly impaired. This discovery was forgotten for many years, and naturalists almost without exception accepted an untried theory that special senses in the skin of the wings were responsible for the ability of bats to fly without hitting things.

In recent years,* however, bats and their flight were studied anew. A number of experiments showed that they had extremely keen hearing, especially for high-pitched sounds. With sensitive recording devices it was discovered that bats give forth a series of strong sounds, pitched far above the limit of our hearing—45,000 to 50,000 vibrations per second, as compared with our limit of about 20,000.

A soundproof room was divided by a hanging screen of metal wires, set about a foot apart. Bats were temporarily blinded and then made to fly through the wire barrier. Blind bats were as successful as normal bats in this test, confirming the old experiments. But when the bats were gagged so they could not make their sound, or when their ears were plugged so they could not hear it, they had great difficulties. They would not fly without much urging, and when they were forced to fly they went slowly, as if uncertain of themselves, bumping into the wires and even the walls again and again, unable to adjust to the unusual situation.

Blind persons make a similar use of echoes to avoid obstacles. The tapping of a blind man's cane along the sidewalk and the resulting echoes have been widely used for generations as a guide when sight could no longer serve. Studies of the problems of "echolocation" as this method has been called, are now in progress, and improvements in technique may be expected which will add greatly to the well-being of sightless persons.

—(*Courtesy of Journal of the American Museum of Natural History*, 1945, p. 315.)

*Griffin and Galambos, *Journ. Exper. Zool*., LXXXVI (1941), 481-506; *Sci. Monthly*, LVI (1943), 155-162.

THE NOBEL PRIZE AWARDS

PROFESSOR W. PAULI (Switzerland), Princeton University, has been awarded the Nobel Prize for Physics for 1944.

The 1944 prize for Chemistry has been won by PROFESSOR OTTO-HAHN (Germany). The 1945 prize goes to PROFESSOR ARTURI VIRTMEN (Finland).

The 1945 prize for Medicine has been awarded jointly to SIR ALEXANDER FLEMING, SIR HOWARD FLOREY and DR. E. B. CHAIN for their contributions to penicillin.

The International Red Cross, Geneva, receives the Peace Prize for 1944 while MR. CORDELL HULL wins the Peace Prize for 1945.

LETTERS TO THE EDITOR

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TESTS OF SIGNIFICANCE BY ANALYSIS OF COVARIANCE IN MULTIVARIATE POPULATIONS

THE statistical significance of two multivariate samples can be judged by any one of the three methods mentioned below:—

1. Hotelling's T^2.
2. Discriminant function.
3. D^2-Statistic.

Prof. Fisher[1] after indicating the relations between these three tests has extended them to the examination of collinearity and coplanarity of samples and to testing the significance of the deviations in directions. Following Prof. Fisher, Roy[2] has obtained the distribution of the p-statistics for any number of samples. In this note I propose to show the relation between the T^2-test and the analysis of covariance.

Taking first the case of two samples it is known that

$$1+\frac{T^2}{N-1}=\frac{|\,e_{ij}\,|}{|\,e_{ij}\,|},$$

where $|\,a_{ij}\,|$ and $|\,e_{ij}\,|$ are the generalized variance within the samples and the two samples together. Using Yule and Kendall's[3] notation it has been shown (Krishna Iyer[4]) that

$$\frac{|\,a_{ij}\,|}{|\,e_{ij}\,|}=\frac{S^2_1\,S^2_{2.1}}{S''_1\,S''_{2.1}}\cdots\frac{S^2_{n.12\cdots n-1}}{S''_{n.12\cdots n-1}},$$

where S^2 and S'^2 are the residual variances on the basis of size of samples within and the two samples together after fitting the regression equations. The degrees of freedom for $S^2_{r.12\cdots r-1}$ and $S'^2_{r.12\cdots r-1}$ and n_1+n_2-r-1 and n_1+n_2-r respectively; n_1 and n_2 being the sizes of the samples.

If there are more than two samples, then also

$$\frac{|\,a_{ij}\,|}{|\,e_{ij}\,|}=\frac{S^2_1\,S^2_{2.1}\cdots S^2_{n.12\cdots n-1}}{S''_1\,S''_{2.1}\cdots S''_{n.12\cdots n-1}}=W.$$

But the distribution of $\frac{|\,a_{ij}\,|}{|\,e_{ij}\,|}$ is very complicated when the number of samples is more than three. For three samples the distribution is given by

$$\frac{\Gamma\frac{N-1}{2}}{\Gamma\frac{N-n-1}{2}}\frac{\Gamma\frac{N-2}{2}}{\Gamma\frac{N-n-2}{2}\cdot\Gamma n}W^{\frac{N-n-4}{2}}(1-W)^{n-1}$$

$$F\left[\frac{n-1}{2},\frac{n}{2},n,(1-W)\right],$$

where F as usual denotes a hypergeometric series; N and n are the size of the three samples together, and the number of variates involved in the samples. For more than three samples also the distribution can be obtained by using the methods given by Wilks.[5] But the expressions are very complicated and hence probably it would be easier to test the significance by taking the ratios $S^2_{r.\,12\cdots r-1}/S'^2_{r.12\cdots r-1}$ for different values of r.

Imperial Agricultural Research Institute, New Delhi, P. V. KRISHNA IYER.
July 3, 1945.

1. Fisher, R. A., "The statistical utilization of multiple measurements", *Ann. Eug.*, 1938, **8**, 376-386. 2. Roy S. N., "Analysis of variance for multivariate normal populations. The sampling distribution of the requisite p-statistics on the null and non-null hypothesis," *Sankhya*, 1942, **6**, 35-50. 3. Yule, U. G., and Kendall, M. G., *An Introduction to the Theory of Statistics*, G. Griffin & Co., Ltd., London, 1940, 259-284. 4. Krishna Iyer, P. V., "A note on Hotelling's T^2," *Curr. Sci.*, 1945, **14** 173-175. Wilks, S. S., 'Certain generalizations in the analysis of variance," *Biom.*, 1932, **24**, 471-94.

RADIATIVE EQUILIBRIUM OF THE ATMOSPHERE AND THE THERMAL STRUCTURE OF THE TROPOSPHERE

THE earth and its atmosphere constitute a system which is continually absorbing short-wave solar radiation and re-radiating it back into space in the form of long-wave heat radiation. The theory of radiative equilibrium demands that on the average and considered over a long interval of time, the total amount of solar radiation absorbed by the system should be exactly balanced by the total amount cutgoing terrestrial rediation. Because of the fact that the atmosphere is largely transparent to the incoming solar radiation (barring the absorption in the ultra-violet due to ozone whose centre of gravity is probably above 20 gkms.), most of the short-wave radiation is absorbed either at the surface of the earth or in the layers of the atmosphere close to the surface. On the other hand, except in certain narrow spectral bands where they are either partially or completely transparent, the water vapour and carbon dioxide present in the atmosphere are highly opaque to wave-lengths in the range of terrestrial radiation. As a consequence, most of the heat radiation sent out from the earth is absorbed by the water vapour and carbon dioxide in the first few metres of the atmosphere. Atmospheric water vapour and carbon dioxide in their turn re-radiate energy in the same range of wave-lengths over which they absorb. But the radiation from any layer of the atmosphere is absorbed in the layers above and below it, and this process of radiation and absorption goes on from layer to layer until we reach a level in the atmosphere above which the amount of water vapour and carbon dioxide is insufficient to absorb completely all the radiation coming from below. Radiation into outer space commences from such a level.

From his study of the emission and absorption by water vapour in the atmosphere, F. Albrecht[1] arrived at a result of fundamental importance regarding the flux of long-wave heat radiation in the atmosphere. He found that practically the entire energy lost to space from the atmosphere originates from a layer of some 3 to 4 kms. thickness in the upper troposphere which he designated as the *Emission Layer*. The height and thickness of Albrecht's emission layer depends upon the water vapour content of the atmosphere. According to Albrecht's estimates the emission layer should lie approximately between $-40°$ C. to $-60°$ C. in the humid tropical atmosphere and between $-30°$ C. to $-50°$ C. in the atmosphere over polar and temperate latitudes where the moisture content is less. The top of the emission layer coincides with the tropopause in polar and temperate latitudes while on account of the violent penetrative convection the tropopause is carried a few kilometres above the top of the emission layer in the tropics.

Taking into consideration convective and radiative processes in the atmosphere, Bjerknes and collaborators[2] have given diagrammatically a meridional section of the atmosphere shownig the probable vertical distribution of the zones of gain and loss of heat energy. This diagram shows a striking difference in the vertical distribution of heat and cold sources in summer and in winter over a place at about the latitude of Agra (lat. 27° 08') and suggests that the thermal structure of the atmosphere over such a place in summer and in winter should be very different.

From an analysis of the records of over 500 sounding balloons let off from Agra during the period 1929-38, I have found that a number of features relating to the thermal structure of the atmosphere over this place can be explained on the basis of the existence of Albrecht's emission layer in the upper troposphere and the seasonal variation of its altitude. The more important of these features are:—

(1) Occurrence of super-adiabatic lapse-rates between 11 and 15 gkms. over Agra in the monsoon months.

(2) Occurrence of comparatively high lapse-rates between 7 and 11 gkms. in the winter months.

(3) Sudden decrease in the lapse-rates above 10 or 11 gkms. in the winter months (*vide* Fig. 1).

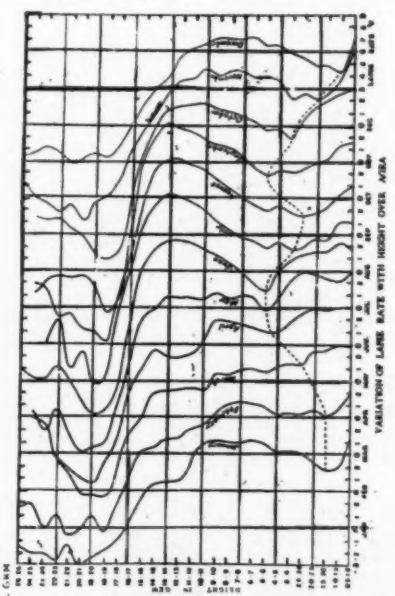
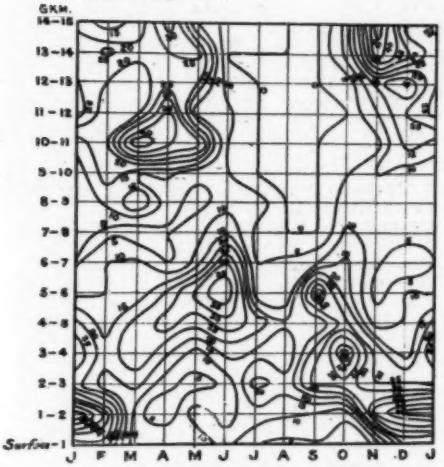


FIG. 1

(4) Composite type of tropopause encountered over Agra in the non-monsoon months.

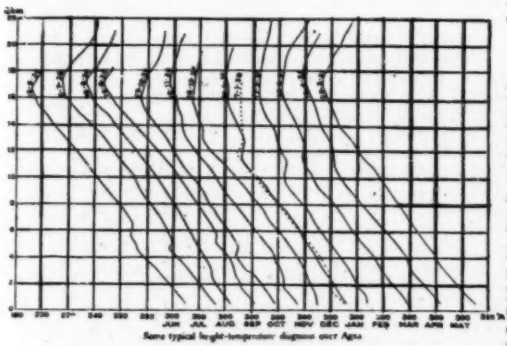
(5) Large frequency of occurrence of inversions and isothermal layers above 10 gkms. in the non-monsoon months (*vide* Fig. 2).



Isopleths of percentage frequency of inversions and isothermals over Agra.

FIG. 2

(6) Very pronounced inversion at the tropopause in the monsoon months but less pronounced inversion at that level, in the non-monsoon months (*vide* Fig. 3).



Some typical height-temperature diagrams over Agra

FIG. 3

(7) Occurrence of a very pronounced maximum in the annual range of temperature over Agra at 9 gkms. and of a less pronounced maximum at 18 gkms. (*vide* Fig. 4)

A detailed paper on the subject is being published as a *Memoir of the India Meteorological Department*. The investigation was completed in April 1942, but the paper could not be published on account of war-time restrictions.

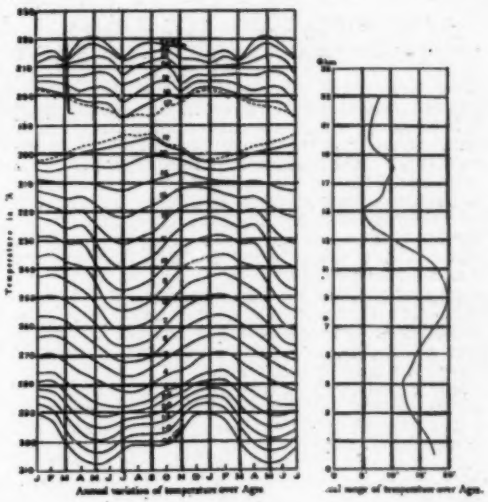


FIG. 4

Meteorological Office,
Upper Air Section,
Poona 5, R. ANANTHAKRISHNAN.
October 29, 1945.

1. Albrecht, F., *Zeit. f. Geophysik*, 1930, **6**, 420. —, *Met. Zeit.*, 1931, **48**, 57. 2. Bjerknes, V., Bjerknes, J., Solberg, H., and Bergeron, T., *Physikalische Hydrodynamik*, 1933, 665–67.

TAMARIND SEED PECTIN

IN a previous publication[1] it was reported that when an aqueous extract of tamarind kernel is treated with twice its volume of alcohol, a voluminous fibrous precipitate is obtained and that it forms a well-set jelly in acid medium, when mixed with an appropriate amount of sugar. On account of this characteristic property the substance was designated as pectin. The material as obtained by this method usually contains 14 per cent. of proteinous matter, some carbohydrates, and a little combined phosphorus, and the removal of these associated substances, especially the proteins, is often difficult and tedious. It has now been noticed that if, instead of using the seed flour as the starting material, pounded seeds (size of a sweet pea) are taken for extraction, most of the proteins and fibres remain with the swollen seeds and the pectinous matter passes into solution, giving a purer material. By dissolving in water to form a thin solution, centrifuging and subsequently precipitating with alcohol, the pectinous substance containing below 1·5 per cent. of protein is easily obtained. Further lowering of the protein content is possible by repeating the operations a few times. Final purification may also be effected by preparing

either the copper or the barium compounds and regenerating the substance.

The aqueous solution of the pure material is dextrorotatory and does not reduce Fehling solution. It has a very low acid number.[2] In its colour reaction with iodine the substance differs considerably from starch. When only a few drops of iodine are added to 0·5 per cent. solution, a bright yellow colour is formed; but with excess a greenish blue colour is produced. The latter colour, however, changes to yellow almost at once, if diluted with water. The substance yields metallic compounds with cupric ammonium sulphate, Fehling solution, barium hydroxide and basic lead acetate, which separate out from water as flocculent precipitates. Purified through any of the salts by treatment with appropriate acid, it retains in full the jelly-forming properties. On addition of borax its aqueous solution is readily converted into a thick gel.

Nanji *et al.*[2] have shown that tamarind seed pectin differs from fruit pectins in properties and composition. Our experiments also lead to similar results. Unlike fruit pectin it does not contain any uronic acid nucleus or methyl ester grouping. Our further experiments show that on hydrolyses with 5% sulphuric acid it yields xylose, galactose and glucose and on oxidation with nitric acid, mucic and saccharic acids as the primary products. But we have not been able to get *l*-arabinose amongst the products of hydrolysis or repeat the other data reported by Damodaran and Rangachari.[3]

Tamarind seed pectin seems to resemble seed-pectins more than fruit-pectins. The seed pectin, for example, from coffee, does not contain any uronic acid nucleus but on the other hand is reported to yield galactose and pentose on acid hydrolysis and mucic acid on oxidation with nitric acid.[4] Experiments aiming at the elucidation of the constitution of tamarind seed pectin are in progress, and the details will be published elsewhere.

T. P. Ghose.
S. Krishna.

Chemical Laboratories,
Forest Research Institute,
Dehra Dun,
August 1, 1945.

1. Ghose and Krishna, *J.I.C.S., Ind. & News Ed.*, 1942, **5**, 114. 2. Nanji *et al.*, *Curr. Sci.*, 1945, **14**, 129. 3. Damodaran and Rangachari, *Curr. Sci.*, 1945, **149**, 203. 4. Gorter, *Ann.*, 1908 **359**, 235.

A NEW METHOD FOR MEASURING THE TIME OF SETTING OF GEL-FORMING SYSTEMS

Several methods have been suggested for the measurement of the time of setting of gel-forming systems which is the main property characterising a gel. The setting condition has been variously defined such as the approach of a certain value of viscosity or the attainment of a constant value of some optical property. The viscosity methods employ certain criteria involving a number of arbitrary experimental conditions. For instance, Flemming's method[1] requires that the container must be filled up to a particular volume; Hurd and Letteron's method[2] requires that a particular length of rod of a specific diameter should be dipped at a particular angle in the gel-forming solution; if Fells and Firth's method[3] is employed, it is necessary that the air bubbles should be blown at a particular rate or pressure. If these conditions are changed, different values of the time of setting are obtained. Further, in the methods involving viscosity considerations, the gel-forming system as a whole has to be disturbed several times during measurement, this disturbance being the least in the case of Hurd and Letteron's method. Methods involving the actual measurement of viscosity should give values far from truth because these measurements, by any method, involve continual disturbance of the gel-forming system. This disturbing factor is wholly eliminated if optical properties are employed, but it has been shown that methods depending upon these properties are inapplicable in the case of systems which are either optically void or highly opaque. The authors have devised a method in which the least disturbance is given to the gel-forming system and no arbitrary conditions are prescribed.

When a body is made to vibrate up and down in a liquid, ripples are produced which spread outward along the surface of the liquid, and become feebler, through attenuation, as the circles become larger, and their amplitude is reduced as they progress. The logarithmic decrement of these ripples depends upon the resistance offered by the liquid, the damping effect. In the case of a gel-forming system, the resistance is predominantly offered by the viscosity of the system which increases during setting. This will increase the logarithmic decrement, and will, therefore, decrease the distance travelled by the ripples. The propagation of the ripples will stop when the viscosity becomes very high. Hence, if ripples are produced in a gel-forming system, they will be propagated quite freely in the beginning; in course of time, the distance travelled by them will decrease and after a certain time no ripples will be propagated. This condition would, therefore, indicate that the gel has set.

The actual experimental conditions were realised by means of a ripple projector provided with a stroboscopic arrangement. The gel-forming solution was contained in a watch-glass, and the height of the vibrating fork was so adjusted that the gel-forming system as a whole was not disturbed. It was observed that initially the ripples spread over a large area, but their size diminished as the setting point is approached and the propagation stopped completely when the gel had set. The time taken by the gel-forming system to reach this condition has been taken as the time of setting. The diminution in the extent of the area to which the ripples spread can be seen from the disappearance of the ripples from the far end, and by noting the successive disappearances of the several ripples it is possible to surmise the velocity of gelation of the system.

The values of the time of setting obtained by this method, with both inorganic and organic gels, are correct within 2 to 3 per cent. and are independent of the frequency of the vibrating fork and the size and shape of the vessel containing the gel-forming system. The disturbance imparted to the setting gel is minimum; this makes the present method more accurate and superior to the other methods used so far. A detailed account of this work will be published elsewhere.

The authors are grateful to Professor Mata Prasad, D.Sc., F.R.I.C., for his keen interest during the progress of this work. Thanks are also due to the authorities of the University of Bombay for the award of a Research Scholarship to one of the authors (G.S.H.).

G. S. Hattiangdi.
S. S. Dharmatti.

Chemical Laboratories,
Royal Institute of Science,
Bombay,
October 8, 1945.

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CATALYTIC DEHYDROGENATION OF BUTENE TO BUTADIENE

In the course of our investigation on the catalytic dehydrogenation of butene to butadiene in the presence of carbon-dioxide, a specially prepared ironoxide-chromia-alumina catalyst exhibited remarkable activity. Contrary to the usual belief that iron or its oxides are unsuitable as dehydrogenation catalysts in the case of olefins, we have found that a catalyst of the type Fe_3O_4-Cr_2O_3-Al_2O_3 can promote simultaneously dehydrogenation and water-gas reactions in butene-CO_2 system, resulting in very high yields of butadiene:

$$[CH_3-CH=CH-CH_3 \rightleftharpoons CH_2=CH-CH=CH_2 + H_2] \quad (1)$$

$$CO_2 + H_2 \rightleftharpoons CO + H_2O \quad (2)$$

The presence of excess of CO_2 in the system is necessary to prevent formation of free iron in the catalyst as this would cause considerable fission of the C-C bonds. The catalyst was prepared by co-precipitating the hydroxides of iron, chromium and aluminium from a mixed solution of their nitrates. The hydroxide gel was dried and reduced in a current of hydrogen at 550-600° C. for 8 hours. The free iron in the catalyst was then oxidised preferentially to magnetic oxide by CO_2 at 500° C. according to $3\,Fe + 4\,CO_2 \overset{< 530°C}{\rightleftharpoons} Fe_3O_4 + CO_2$. The best catalyst was found to be the one containing 15 per cent. Fe_3O_4, 80 per cent. Cr_2O_3 and 5 per cent. Al_2O_3. The results of careful experiments in a flow system showed that at 600° C. and in the absence of CO_2 the catalyst causes 12-14 per cent. dissociation of butene to butadiene. When CO_2 was used with butene in the ratio of 2:1, interesting results were obtained. At the temperature of about 580° C., the formation of butadiene was maximum, being 38 per cent. on the unsaturates per pass which, however, slowly fell with time to a constant conversion rate of 30-32 per cent. The degree of fission was as low as 5-10 per cent. on the butene passed. At temperatures below 580° C., the rate of dehydrogenation was slow while above that temperature the yield of butadiene remained practically stationary. Data for a few typical experiments are given in the accompanying table.

The efficiency of the iron catalyst will be evident on comparing the above data with Balandin's,[1] whose best results involve use of butene to CO_2 in the ratio of 1:7. In the temperature range of 570-600° C. he obtained yields of 27-34 per cent. butadiene (fission 20-25 per cent.) on butene passed and the concentration of butadiene was not greater than 4 per cent. in the contact gas. Working at the reduced pressure of 180 mm., Grosse and co-workers[2] could obtain about 22 per cent. yield of butadiene with 20 per cent fission.

In order to elucidate the mechanism operative on Fe_3O_4-Cr_2O_3-Al_2O_3 catalyst, quantitative measurements of the reaction were made. It was found that hydrogen was practically absent in the reacted gases and carbon monoxide was formed in large quantities. Also no liquid products were formed with this catalyst. The former is explained by the fact that iron oxide, which is known to be a good catalyst for water-gas reaction,[3] is responsible for the formation of CO and removal of free hydrogen which is formed through dissociation of butene:

$$CO_2 + H_2 \rightleftharpoons CO + H_2O \quad (2)$$

$$Fe_3O_4 + H_2 \rightleftharpoons 3FeO + H_2O \quad (3)$$

No.	Temp. °C.	Space velocity	Ratio of butene to CO_2	Analysis of the gases collected, in%				Yield of Diene %	Fission %	Concn. of butadiene in contact gas in %
				CO_2	CO	Unsatd. hydrocarbons	Satd. hydrocarbons and residue			
1	555	550	1:2	57	3·5	33·0	6·5	18·0	6·0	6·0
2	575	,,	,,	57	2·1	34·0	6·9	25·0	4·0	8·5
3	585	557	,,	55	6·2	25·2	13·6	38·9	10·0	9·8
4	580	550	,,	51·5	9·5	22·5	16·5	34·2	7·8	7·7
5	585	,,	,,	61·4	4·2	30·3	4·1	30·6	8·0	9·3
9	600	,,	,,	52·9	13·7	21·3	12·1	29·0	11·0	6·2

The activity of the catalyst, however, does not change, once a steady state is reached, due to the regeneration of Fe_3O_4 *in situ* by CO_2

$$3\ FeO + CO_2 \rightleftharpoons Fe_3O_4 + CO \quad \ldots\ldots \quad (4).$$

Carbon dioxide also helps to remove free carbon which might have been formed though fission on the surface of the catalyst: $C + CO_2 \rightleftharpoons 2\ CO$, thus maintaining the activity of the catalyst steady for long periods. In order to verify that iron initiates the above reaction mechanism only when associated with $Cr_2O_3 - Al_2O_3$ in the form of its magnetic oxide, a catalyst composed of iron chromite (prepared by a method similar to Adkin's[4] method) and alumina was made and studied under conditions exactly similar to those given above. Under best conditions, it was found that this catalyst causes only 16-18 per cent. dissociation of butene to butadiene.

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BIOLOGICAL ASSAY OF THE OVERALL POTENCY OF THE GROWTH FACTORS ASSOCIATED WITH YEAST AUTOLYSATES AND LIVER EXTRACTS

The suitability of *Corcyra cephalonica* Staint. (rice moth) larvæ for the assay of some of the vitamins of B-complex has already been demonstrated. We have now explored the possibility of assaying the overall growth-promoting potency of yeast autolysates and liver extracts employing these larvæ as test animals.

A synthetic basal diet consisting of vitamin-free starch (B.H.D.), casein (B.H.D.), sucrose treated with "norit" and recrystallised and salt mixture was used. A composition of the salt mixture was as follows:—

Calcium lactate 35·15 g., $Ca(H_2PO_4)2\ H_2O$ 14·60 g., K_2HPO_4 25·78 g., $Na_2HPO_4\ H_2O$ 9·38 g., NaCl 4·67 g., $MgSO_4$ 7·19 g., Iron citrate 3·19 g.

The basal diet was compounded as follows:—

Starch 18·0 g., Casein 1·0 g., Sucrose 1·0 g., Salt mixture 0·5 g.

One ml. of a 1:1 mixture of cod-liver and refined groundnut oil served to supply the necessary fat-soluble growth factors.

Experimental Details

A. *Yeast autolysate* was prepared by autodigesting 10 g. of air-dry yeast (S. cerviseæ) with 40 ml. toluene-saturated water at 40° C. for 18 hours. On centrifuging the suspension, the extract was decanted and made up to 40 ml. with water; this extract was found to contain 9·73 per cent. of total solids.

Experimental diets fortified with 1 ml. and 2 ml. of the yeast autolysate were prepared.

Newly hatched rice moth larvæ were fed for the first ten days on whole jowar and thereafter maintained on starch-casein-basal diet from which the oil had been excluded. Finally they were transferred to the experimental diets. Whole jowar and the basal diet, with and without the oil were used as controls.

B. (1) *Liver extract* (Cohn's faction G.) obtained from the Industrial Testing Laboratory, Bangalore, was dissolved in water so as to give a solution with a total solid content of 9·73 g. per cent.

Experimental diets each containing 1 ml., 3 ml. and 5 ml. of the liver extract were prepared.

(2) *Autoclaved liver extract.*—Further experiments were carried out with liver extract, autoclaved at 30 lbs. for 4 hours. Diets were prepared each containing 1 ml. and 3 ml. of the autoclaved liver extract. Feeding experiments with a diet containing 3 ml. of the un-autoclaved liver extract together with an adequate control, were also carried out. Results are given in Tables II and III.

Table I

Diet	Average wt. of 10 larvæ in mgm. after						
	0 days	7 days	14 days	21 days	28 days	35 days	
I. Basal diet without oil	3·09	4·69	5·33	5·75	one survived	one survived	No pupæ
II. Basal diet with oil	3·17	6·67	7·60	7·57	7·24	10·75	..
III. Basal diet II + 1 ml. yeast autolysate	2·98	5·28	12·21	29·83	51·05	53·45	2 pupæ
IV. Basal diet II + 2 ml. yeast autolysate	3·31	8·83	33·92	75·38	117·34	Most pupated	Most pupated
V. Whole jowar	3·29	31·17	94·86	99·70	All pupated	All pupated	All pupated.

TABLE II

Diet	Average weight of 10 larvæ in mgm. after.					Remarks
	0 day	14 days	21 days	28 days	35 days	
I. Basal diet (*a*)	16·32	16·64	5·98	8·34	10·58	No pupæ.
Without oil (*b*)	17·50	11·58	20·50	16·18	15·16	..
II. Basal diet (*a*)	16·30	23·26	22·60	18·96	15·18	..
+oil (*b*)	16·06	15·28	16·82	14·26	14·48	..
III. Basal diet II (*a*)	15·02	48·40	53·62	58·46	67·46	..
+1 c.c. Liver extract (*b*)	16·58	34·22	25·94	30·84	47·34	..
IV. Basal diet II (*a*)	14·66	50·16	..	..	..	..
+3 c.c. Liver extract. (*b*)	16·38	61·18	52·36	56·64	59·90	..
V. Basal diet II (*a*)	14·00	46·16	61·22	82·34	..	1 pupæ.
+5 c.c. Liver extract (*b*)	15·26	46·18	..	..	..	..

TABLE III

Diet	Average wt. of 10 larvæ in mgm. after			
	0 day	14 days	25 days	35 days
(*a*) Basal diet II + 3 c.c. autoclaved Liver extract	6·04	14·24	16·60	13·74
(*b*) Basal diet II + 3 c.c. unautoclaved Liver extract	5·85	11·05	36·80	72·84

It will be seen from the tables that the insect responds definitely to the fortification of its basal diet with yeast autolysates and liver extracts and a roughly quantitative relationship may be perceived to exist between growth and the degree of enrichment. Both from the point of view of the rate of growth and of percentage of pupation, yeast autolysate gives a result which is far more satisfactory than that obtained with liver extract. It is revealed that autoclaving at 30 lbs. for 4 hours appears to destroy the growth-promoting factors associated with the liver extract.

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STABILITY OF VITAMIN C IN DRUMSTICK LEAF

THE leaf of the drumstick tree (*Moringa oleifera*) has long been known to be a rich source of ascorbic acid,[1,2] providing 900 to 1,100 mgs. per cent. of this vitamin. The edible portion of the pod also contains nearly one per cent. of the vitamin and, being free from interfering substances, was at one time suggested as a suitable standard for titrating indo-phenol indicator solutions.[1] The leaf, however, contains, in addition, 100 to 110 mgms. per cent. of β-carotene[2,3] as determined spectrophotometrically after phase separation and chromatographic adsorption over Brockman's alumina[4] and is, therefore, richer in this respect than either lucerne[5] or rose hip,[6] two of the natural sources of ascorbic acid and carotene which have been successfully processed[7,8] to yield rich concentrates.

In the course of investigations on the processing of drumstick leaf by fractionation and dehydration methods so as to obtain rich concentrates of ascorbic acid and carotene, interesting results were obtained in regard to the relative stability, under ordinary conditions of exposure, of ascorbic acid in aqueous extracts when examined during pre-flowering (October-November) and flowering stages (January-February). Some typical data are reported in Table I where the results for lucerne leaf sampled during the two periods and for an aqueous solution of pure ascorbic acid are included for comparison.

TABLE I

Stability of ascorbic acid in plant sources

Source	Mgm. per cent. ascorbic acid in			
	HPO_3 (5 per cent. Extract)	Aqueous extract at the end of		
		0 hrs.	24 hrs.	72 hrs.
Drumstick leaf–pre-flowering stage	1,143	888	840	666
Drumstick leaf-flowering stage.	985	112	64	..
Drumstick flowers I	1,250	50	..	..
Drumstick flowers II	1,665	66	..	..
Lucerne leaf sampled in October	960	841	328	294
Lucerne leaf sampled in February	920	800	278	237
Ascorbic acid (pure)	25	21	9	..

These results show that a water extract of drumstick leaf is remarkably stable when

sampled during the period of maximum vegetative growth, there being only 25 per cent. loss in ascorbic acid even after three days' storage. On the other hand, a powerful oxidase system is apparently developed in the leaf when the tree is in flower, more than 80 per cent. of the vitamin being lost during extraction alone. This oxidase activity is even more with the flowers where practically the whole of the ascorbic acid is destroyed instantaneously in the aqueous extract.

Whether the destruction of the ascorbic acid during extraction with water and subsequent storage has been due to the specific oxidase elaborated during flowering has not been fully investigated. But, in experiments with aqueous ascorbic acid, addition of a heated water extract of the leaf sampled at flowering stage resulted in a destruction, during 24 hours, of only 44 per cent. of the original vitamin C content as against 74 per cent. with a corresponding quantity of unheated water extract. These results as also a comparison of the relative stabilities of water extracts of the leaf and of aqueous ascorbic acid would suggest that, in addition to the oxidative heat-labile enzyme, plants contain a thermostable protective factor as postulated by Krishnamurthy and Giri.[10] It cannot, however, be stated on the basis of existing knowledge that the activities of the oxidase and of the protective factor could vary independently in different plants and during different seasons.

The foregoing observations on drumstick leaf have been amply confirmed from an examination of a large number of flowering trees. Besides, the non-existence of a powerful oxidase system was demonstrated during the same season in two instances where the trees were not in flowers due either to immaturity or to excessive defoliation.

In contrast with drumstick leaf, the results obtained with lucerne do not show any wide variation in oxidase activity during the two consecutive seasons; but, it must be borne in mind that this plant is grown largely for its fodder and that, therefore, cuttings are taken frequently, as was the case in the present instance, thereby preventing its reproductive phase. Presumably, this modifies the effect of season on the ascorbic acid-ascorbic oxidase system.

That seasonal variations in the concentrations of ascorbic oxidase and of dehydro-ascorbic acid reductase[11] may be considerable is shown by the results of Crook and Morgan[12] for cauliflower. The evidence recorded here would strongly suggest that these enzyme systems concerned in the reversible oxidation-reduction of ascorbic acid are of possible significance in the biosynthesis of this vitamin in plants. Support is lent to this view by the recent findings of Zilva, Kidd and West[13] that there is a decrease in the ratio of dehydro-ascorbic acid to ascorbic acid in the total vitamin C content of the apple as the fruit approaches maturity. No attempt has been made to follow up the dehydro-ascorbic acid and its reductase contents in drumstick leaf during the different developmental stages of the plant, but there is little doubt that such a study will eventually yield information of physiological importance.

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PHOTOPERIOD IN RELATION TO FLOWERING IN SUGARCANE

AT a breeding station it often becomes necessary to control the flowering of varieties in order to effect certain crosses. In sugarcane the problem is not only of controlling the time of flowering but also of inducing certain varieties to flower as quite a number of them do not usually flower under the normal conditions. As is well known the 'day-length factor' greatly influences the transition from the vegetative to the reproductive phase. The study of 'day-length factor' has recently received increasing attention at the Imperial Sugarcane Breeding Station, Coimbatore. The earlier work at Coimbatore started in 1932 (Dutt, 1943) and was concerned mainly with the delaying and hastening of the flowering time in certain commercial cane varieties. Sartoris (1938) and also Allard (1939) studied the effect of different day-lengths on *Saccharum spontaneum* 28, NG 292 and observed that this variety produced rudiments of flowers only with 13 hours day—the full day of the locality of the experiment—and that slight alterations in the duration of the day inhibited flowering.

Recently the writers took up for study two of the forms of *S. spontaneum* which do not normally flower at Coimbatore. It was considered desirable to study the photoperiodic response in such varieties as many of them would be very useful breeding material if they could be induced to flower. The photoperiodic response of three cultivated varieties was also studied.

The variety *S. spontaneum* (Burma)—a tall vigorous variety which does not flower at Coimbatore, was induced to flower by subjecting it to long periods of darkness about eight weeks prior to the commencement of flowering season. This variety was planted in the field in December 1942 and was allowed to grow under the normal conditions for the first eight months. At this stage a number of top portions consisting of upper half of a primary stalk were removed from the field and planted upright in large-sized pots, one in each pot, containing the ordinary garden land soil. (Top portion represents the upper half of a

Treated Control

FIG. 1. Showing the effect of long periods of darkness on 8 months old tops of the non-flowering variety *S. spont.* Burma

primary stalk.) When the tops had resumed growth, i.e., after about 20 days of planting, these were divided into different series, of 5 pots each, and one of these series was daily given only two hours of daylight from 12 noon to 2 p.m., and for the rest of the day it was kept in a dark-room. This treatment was continued for two months—from 10th September to 10th November—and then the plants were restored to normal day-length conditions. About three weeks after stopping the treatment all the tops began to show indications of flowering and at the end of December one of them arrowed (Fig. 1). The arrow was normal and healthy. The remaining stalks were dissected and examined and they revealed the presence of young developing flowers. The series subjected to other day-length treatments, namely, 10 hours, 14 hours, 22 hours and the normal daylight did not show any sign whatever of flowering.

The above experiment was repeated and confirmed during the year 1943-44; some arrows which were obtained were successfully utilized for crossing.

S. spontaneum (Assam 301) is another wild form which does not normally flower at Coimbatore. During the year 1942-43 it was grown in the field under different lengths of day to determine the photoperiodic conditions suitable for its flowering. The planting was done on 12th February 1943. Single rows of 20 plants were used for each of the following five-day length treatments—6, 9, 15, 18 hours and the full day. The treatments were commenced when the plants were one month old and were continued to the end of the experiment. The artificial light was obtained from 100 C.P. electric bulbs and extra darkness was provided by special light-proof enclosures erected in the field. This variety flowered with 9 hours day-length The first arrow emerged on 16th September, i.e., 7 months after planting. Subsequently 18 more arrows emerged, all normal and healthy, the flowering continued to the middle of October. The other treatments including the normal day did not give any indication of flowering.

The times of flowering of certain cultivated cane varieties were delayed by seven to eight weeks by varying the length of day; this period of eight weeks practically covers the range of disparity in the times of flowering of late and early varieties at this station. Three varieties were studied, *viz.*, P.O.J. 2725, P.O.J. 2714 and Co. 421. These were planted in the field, in rows, on 6th December 1942. Five day-lengths were used, *viz.*, 6, 9, 15, 18 hours and the full day. The arrangements for controlling the day-length were made in the field, as described above. The treatments were commenced when the plants were three months old and were continued for another three months, i.e., till the end of 6th month. The results obtained were as below:—

With the normal daylight conditions the variety P.O.J. 2725 flowered on 22nd September 1943 and the flowering continued till 15th October 1943. With 18 hours day-length flowering commenced on 21st October, i.e., one month later, and continued till 8th November 1943. With 6 hours day-length flowering commenced on 19th October and continued till 29th December, i.e., the arrows of this variety were available for crossing even two months after the control had finished off flowering. With other day-lengths, i.e., 9 hours and 16 hours, the differences in the time of flowering were not so marked.

The variety P.O.J. 2714 flowered under the normal conditions on 10th October 1943 and it continued to flower till 27th October 1943. With 18 hours the flowering commenced on

15th November, i.e., about 36 days later, and the arrows continued to emerge till 14th December, i.e., 47 days after the control had finished off flowering. With other day-lengths the differences in the time of flowering were not so marked, except that with 6 hours day-length the flowering commenced 22 days later.

The variety Co. 421 flowered with 18 hours day-length one month later than the control and the flowering continued till 16th November whereas in the control plants it finished off on 23rd October.

It also seems worthy of mention that potted top portions (described above) of Co. 421, a pollen sterile variety, when supplied with 3 hours of extra light, i.e., 15 hours day-length, about seven weeks before the flowering was due, i.e., from 6th September to 20th October 1943, yielded 80 per cent. open anthers and healthy and well-developed pollen, which gave about 10 per cent. germination. The electric bulbs used in this experiment to supplement the daylight were of 500 C.P. The tops subjected to other day-length treatments, viz., 24 hours and the full day did not yield any pollen.

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TWO NEW RECORDS AND A NEW SPECIES OF THE GENUS *TRICHURIS* FROM DOMESTIC RUMINANTS

Ostertagia pinnata and *Ostertagia gruhneri* are recorded from the material collected from Mukteswar in September 1942 while *Trichuris ovina*, a very common and widely distributed parasite was observed from various regions of the Punjab and United Provinces in different parts of the year.

Ostertagia pinnata Daubney (1933)

Daubney (1933) described the species from Kenya, its distribution being restricted to Romney Areas (Highlands) only. The present record is based on the presence of a single male specimen in a collection from Mukteswar. The individual possesses all the characteristics of the species, measures about 10 mm. long and has a width adjacent to the anterior ends of the spicules of about 0·14 mm. The spicules measure about 0·26 mm. each. Host—*Ovis aries*; Location—Abomasum; Locality—Mukteswar (Kumaon).

Ostertagia grühneri Skrjabin (1932)

The parasite was originally recorded from a reindeer in Russia. Dikmans (1939) records it from *Ovis canadensis*, *Ovibos moschatus* (musk ox), *Rangifer tearandus* (reindeer) from North America. The spicules of the specimen in this collection are dark yellowish brown in colour and measure about 0·16 mm. long each. Gubernaculum is absent. Host—*Bos indicus*; Location—Cæcum; Locality—Mukteswar (Kumaon).

Trichuris ovina sp. n.

Male: Length of anterior part is from 32-40 mm.; posterior part 17-20 mm.; breadth of posterior part about 0·5 mm. in the middle of the region of the ejaculatory duct and 0·64 mm. in that of the vas deferens. The body carries a papilla on either side of its posterior end.

The spicule is small and thin having a proximal thickening and ending with truncated edges (Fig. 1) followed by a hyaline part 'b'. It measures from 1 to 1·5 mm. long and about 0·025 mm. broad.

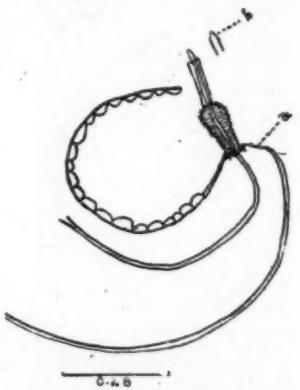

FIG. 1. *T. ovina*; posterior end of male

The sheath, wherever it is everted has a club-shaped appearance, having a length equal to that of the mouth-piece itself of about 0·14 mm. The sheath is studded all over with very fine and dense spines measuring about 0·0015 mm.

The testis starts in the cloacal region, with moderate convolutions in the region of ejaculatory duct, which are, however, closer and more restricted to one side in that of vas deferens. The vas deferens is from 3·9 to 5·2 mm. long; the ejaculatory duct from 11·5 to 12·7 mm.; the cloaca from 1-1·4 mm. with the spicular tube joining it 0·475-0·53 mm. from the posterior end. The constriction joining the ejaculatory duct and vas deferens measures about 0·25 mm. long and 0·15 mm. broad.

Female: Length of anterior part is from 34 to 38 mm.; that of posterior part 15-18 mm. with a breadth varying from 0·45 to 0·54 mm. The vagina resembles in general that of *Trichuris ovis* with the difference that after the first two of three curves there is a dilatation proceeded by distal curves lined with spines. Eggs which are thick-shelled, measure from 0·055 to 0·058 mm. long and 0·024 to 0·026 mm. broad.

Discussion.—The males of the species resemble those of *T. parvispiculum* and *Trichuris discolor* for the short spicule and a pair of papillæ on the posterior part of the body but in the author's species the tip is truncated while it is rounded in the other two. In the author's species the spines on the sheath are fine, closely situated and uniform in distribution while in both the other species the spines are sparse in distribution and are triangular and blunt in the proximal part of the sheath. *T. discolor* has a sheath divided into a proximal tubular part and a bulbous distal part while the sheath in the author's species is club-shaped with a mouth-piece of the same length.

FIG. 2. *T. parvispiculm*; posterior end; male

The vagina in *T. ovis* has a uniform calibre throughout its course while in the author's species the middle curve is dilated.

Trichuris ovina sp. nov.

Specific diagnosis.—Trichurids resembling in general *Trichuris parvispiculum* and having spicular sheaths about 0·14 mm. long with mouth-pieces of approximately the same length; sheath studded with spines; spicule about 1 mm. long and ending with truncated margins; ejaculatory duct about three times the length of vas deferens.

Eggs measuring from 0·055 to 0·058 mm. long and from 0·024 to 0·026 mm. broad.

Host—*Capra hircus*; *Ovis aries*. Location—Cæcum; Locality—Punjab and the United Provinces.

Military Dehydrated Meat Factory,
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August 29, 1945.

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THE SPARING ACTION OF α-TOCOPHEROL ON CAROTENE

MOORE[1] first observed that ingestion of extra vitamin E increased the storage of vitamin A in the liver of rats and lengthened the time taken to deplete them of vitamin A. This work was extended by Hickman and co-workers[2] who showed that vitamin E enhanced the growth-promoting activity of vitamin A and more markedly of carotene, the action being attributed to the antioxidative action of vitamin E. Guggenheim[3] has confirmed the results using a modified method for the bio-assay. Recently, however, Gridgeman[4] reported that workers in his and another laboratory failed to observe any synergism between vitamin A and carotene on the one hand and vitamin E on the other. Though he did not doubt the operation of the synergism, he suggested that it may not manifest under certain conditions (private communication). During the study of factors responsible for the variation in response to carotene when dissolved in different oils, one of us (S.D.R.) obtained evidence of the synergism.[5] The results have now been confirmed on more extended levels of dosage of vitamin E.

A number of vitamin A-deficient rats were each given 0·8 μg. of β-carotene six days in the week and assembled into five groups of six rats, one group receiving no α-tocopherol and the others increasing quantities of it as follows: 0·03, 0·12, 0·50 and 2·0 mg. immediately after the carotene. The vitamins were dissolved in cocoanut oil free from carotene and vitamin E, the total oil intake being 100 mg. per rat at a time. The experimental diet consisted of 68 per cent. sucrose, 18 per cent. extracted casein, 10 per cent. brewer's yeast and 4 per cent. Osborne-Mendel salt mixture fortified with 1 mg. thiamine hydrochloride and 1 mg. of riboflavin per 1 kg. of diet and supplemented with 1 μg. of calciferol per week. The B vitamins were added since Hickman has pointed out the need for their adequate intake. The weekly gain or loss in weight was noted; the results are given in the accompanying table.

Effect of varying supplements of tocopherol on growth induced by 0·8 μg. carotene

Group	Tocopherol supplement mg.	Gain in weight in g. at the end of				
		1 week	2 weeks	3 weeks	4 weeks	5 weeks
1	Nil	1	—4	-7 (1)*	-7(5)	All dead
2	0·03	0	2	5	4 (1)	2 (3)
3	0·12	0	4	5	5 (2)	7 (3)
4	0·50	6	8	10	11	14
5	2·0	3	3	4	8	12

*The figures in parenthesis indicate the number of rats that died during the experiment.

A dosage of carotene which was insufficient by itself to maintain life in rats became sufficient and promoted normal growth when administered together with tocopherol. The optimum tocopherol supplement appears to be the same as that observed by Hickman, viz.,

0·5 mg. per rat, though the diet used here was lower in fat.

Our grateful thanks are due to Prof. V. Subrahmanyan for his kind interest in the work.

S. Dattatreya Rao.
V. Mahadevan.
Y. B. Rangnekar.

Department of Biochemistry,
Indian Institute of Science,
Bangalore,
October 19, 1945.

1. Moore, *Biochem. J.*, 1940, **34**, 1321. 2. Hickman, Harris and Woodside, *Nature*, 1942, **150**, 91. 3. Guggenheim, *Biochem. J.*, 1944, **38**, 260. 4. Gridgeman, "The Estimation of Vitamin A," Lever Bros., and Unilev. Ltd., 1944. 5. Dattatreya Rao, S., *Nature*, 1945 **156**, 449.

*THE ISOPOD PARASITE, *NEROCILA SUNDAICA* ON WEST COAST FOOD FISHES†

The Isopod parasite, *Nerocila sundaica*, was observed quite commonly in a few of the important species of the food-fishes of the West Coast during the months of December 1944, January and February 1945. The species so infested were *Engraulis mystax, Otolithus ruber, Serranus gilberti, Pellona indica, Therapon jarbua* and *Sardinella fimbriata*. The parasite has been found attached at the angle of the pectoral fin in the case of the clupeoids and just posterior to the mandibular symphysis in the case of the perches and the jew fish. This position seems to be very protective enough for the parasite from the force of the currents and from the host.

Description

Head.—Slightly immersed in the first thoracic segment, length nearly half that of the width at its posterior margin. Eyes are large and darkly pigmented. The first antennæ is composed of six segments and second antennæ of equal length has ten segments. The maxillipedes form the floor of the mouth. The mouth appendages are modified for piercing and sucking.

Thorax.—The thorax has seven segments and they become progressively broader till the fifth segment from whence onwards they become little narrower. The thoracic appendages are modified as prehensile organs and form the main organs of attachment. The oostegites are found in the first six pairs of thoracic appendages and they are broad, subovate structures attached to the coxopodite of the appendages.

Abdomen.—The abdominal segments are narrower and clearly demarcated from the thorax. The telson is broad and sub-quadrangular in shape. The abdominal appendages are all biramous and lamellar, the rami of which serve as natatory and respiratory organs. In the male specimen the second pair of pleopods shows a special modification of the endopodite known as Appendix masculina. The uropod also is biramous.

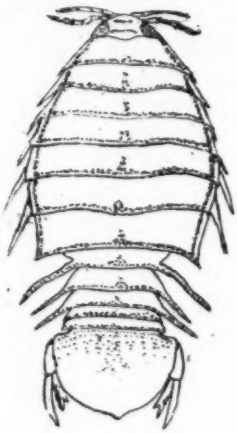

FIG. 1. The Parasite

The specimens vary in length from 1·8 cms. to 2·5 cms. and the width of the body is half as broad as the length. The colour is yellowish white with minute light spots at the posterior portion of the segments.

In specimens of *Engraulis mystax*, measuring 17 cms. and which were not attacked by the parasite, the condition of the gonads was in the second stage of development. In specimens attacked by the parasite and which measured up to 15·5 cms. there was only a trace of gonads. The Anchovies measuring 13 cms. and 14 cms. have been found to spawn in this period previously. As such the retardation of the gonadial development in these specimens 15 cms. long, may partly be attributed to the effect of parasitism of the Isopod.

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West Hill,
October 20, 1945.

* Our thanks are due to Dr. B. N. Chopra, Director of Zoological Survey of India, for kindly confirming the identification.

† With the kind permission of the Director of Industries and Commerce, Chepauk, Madras.

REVIEWS

Industrial Oil and Fat Products. By Alton E. Bailey. (Interscience Publishers, Inc., New York, N.Y.), 1945. Pp. 735. Price $ 10.0.

The book under review is essentially intended to be a text on Oil and Fat Technology in its physical, chemical and economic aspects as it is practised to-day in America (U.S.A.). The author is the senior chemical technologist in charge of the Southern Regional Research Laboratory, U.S. Department of Agriculture at New Orleans, Louisiana and is well-known to readers of *Ooil and Soap* and *Industrial and Engineering Chemistry* by his valuable contributions in recent years to diverse aspects of modern oil technology ranging from studies in specific and latent heats of fusion of oils and fats to fundamental investigations on rancidity, antioxidants, tocopherol from cotton-seed oil, refining and deodorisation of oils, conditions governing production of iso-oelic acid in oil hydrogenation and catalytic rearrangement of glyceride structure in natural and synthetic fats.

The greater part of the book comprising sections C and D and forming sixteen out of a total of twenty-three chapters is devoted to a description and discussion of the commercially important oil and fat products and the processes used in their manufacture, the sections dealt with being cooking and salad oils, plastic shortening agents, butter and margarine, bakery products and confections, soaps, paints, varnishes and related products, and miscellaneous fat products like lubricants, illuminants, cosmetic and pharmaceutical oils, polishes and insecticides.

The unit processes in oil technology which are described in a systematic though brief manner comprise extraction of fats and oils by expression as well as solvent extraction, refining and bleaching, deodorisation, hydrogenation, soap production, fractionation of fats and fatty acids, fat splitting and esterification, polymerisation and isomerisation, including dehydration of castor oil and other ordinary oils, and finally solidification and emulsification of oils.

Much of what the author has presented is based on his own personal experience and as such is quite valuable. The author, however, has had the benefit in other matters of the advice and suggestions of about twenty professional colleagues including G. S. Jamieson, the well-known author of *Vegetable Oils and Fats*. Though the main purpose of the book is technological, the chemical and physical nature of fats and oils has not been neglected, the subject being reviewed in two preliminary sections A and B comprising the first seven chapters dealing with the structure and composition of fats and oils, reactions of fats and fatty acids, the physical properties of fats and fatty acids and the occurrence, production, composition and classification of the common fats and oils. A refreshing feature of the classification adopted in this book is the stimulating departure from the well-known grouping of oils into non-drying, semi-drying and drying oils and their rearrangement into the following groups: milk fats, lauric acid oils, vegetable butters, animal fats, oleic-linolic acid oils, erucic acid oils, linolenic acid oils, conjugated acid oils, marine oils, and hydroxy acid oils. This system of grouping is characteristic of the author's technological standpoint of the industrial utilisation of oils and fats.

However, in the part relating to pure chemical composition of fats and oils the treatment was not expected to be so thorough and occurrence of one or two errors of omission in that regard need not be surprising. For example, the statement on p. 13, line 9, about the occurrence of C_{20}, C_{22} and C_{24} saturated acids in nature, evinces regrettable ignorance of valuable contributions during the last decade and a half to rich sources of these acids in nature in the Sapindaceæ, Mimosæ and Moringaceæ seed group of fats. This does not in any way detract the valuable amount of technical material which is published here for the first time filling up notable gaps which have existed so far in such branches of the technology of the edible fats and oils as plastic shortening agents and bakery products and on the practical operations of refining, bleaching, deodorisation and hydrogenation as these are practised today with the most recent advances in their knowledge incorporated into practice.

The book on the whole is a valuable contribution to modern technological literature on oils and fats forming a tribute not only to the professional enthusiasm and achievements of the author but also to the scientific organisation and administration of the U.S.A. Agricultural Department and every technological institute would be well advised to secure a copy of this publication for the use of their technical staff.

P. Ramaswami Ayyar.
(Miss) R. J. Irani.

Erosion in the Punjab—Its Causes and Cure. By Sir Harold Glover. (The Civil and Military Gazette, Ltd., Lahore), 1944. Pp. 143. Price Rs. 15-7-0 or 23*sh*.

Literature on the complex problems relating to soil erosion with specific reference to Indian conditions is none too plentiful. The Punjab has the distinction of being amongst the pioneer provinces in India to recognise the existence and urgency of soil erosion and to make a beginning with ameliorative measures. But, apart from papers in the professional journals and departmental reports, there was till now no publication giving a connected narrative of the considerable amount of work that has been systematically carried out in that province since 1939. This gap has been filled by the book under review, *Erosion in the Punjab—Its Causes and Cure*, by Sir Harold Glover, late Chief Conservator of Forests, Punjab.

The volume is divided into two parts. Part I, General, gives a brief description of the

country dealt with, the climatic, biotic and human factors influencing erosion, the consequences of erosion and lastly the methods recommended for the check of erosion. The second part is devoted to fairly detailed accounts of the varying conditions in the individual districts of the Punjab and contains summaries of the work done in them so far. These two parts are illustrated by a wealth of photographs (nearly 180 of them) which give the reader an excellent idea of what may be termed the qualitative side of the problem. The book, however, does not include specific quantitative data with regard to experimental plots, run-off volumes, weight of soil removed under defined conditions, the actual protection afforded by different types of vegetation and the like. But, the practical difficulties which a soil doctor—if the term be permissible, for erosion is definitely no more but no less than a disease—encounters in Indian rural communities, the administrative set-up that is required, the organisation of co-operative endeavour and more than all, the gradual building up of informed public opinion on which alone all soil conservation plans ultimately depend for success, all these are dealt with in an admirable manner with illustrative details which reveal a long and intimate knowledge of the problems handled.

A feature of the book is the large number of photographs. Anyone who has attempted to photograph large landscapes to bring out the details of topography and vegetation knows what a difficult job it is. The photographs which adorn this volume maintain on the whole a high standard, a few of them being taken from the air. The pictures tell eloquent tales which sometimes (for example facing p. 16, tap-root of a tree in an eroded field; p. 112, soil loss in an avenue) are startling. In fact, the photographs by themselves would form a very effective and entertaining background for a lantern talk on soil erosion to an Indian audience. The photographs are, unfortunately, neither numbered nor listed in a table of contents so that reference to them is not easy. The general level of these illustrations is so high that one wonders why such specimens as those facing pp. 14, 26, 28 (The Maili Village Co-operatvie Society), 91 and the like, have been included. These latter neither illustrate the text nor convey any significance to the central theme but only disturb the overall excellent impression made by the scores of other telling photographs.

The book carries a preface by His Excellency Sir Bertrand Glancy, a foreword by Sir James Penny and concludes with an appendix on the Bombay Presidency Land Improvement Scheme.

A few minor improvements would considerably add to the convenience of the reader. It is very curious that the "Contents" at the beginning of the book list the chapters but omit the paging. The lack of numbering of photographs has already been referred to. The second part of the book contains several official forms, model bye-laws, draft Gazette notifications and the like (pp. 95-106) which could with effect be divorced from the text and brought together in an appendix. In a volume so well illustrated, the absence of a few maps indicating the geography, rock and soil types and forest types in the area dealt with is a noticeable omission. One also notices occasional statements clothed in picturesque language as, for example, on page 16: "when the trees disappear, the rocks, heated by the direct rays of the sun, radiate out heat until the barren ravines are unbearable, the hot air rises and forces up the clouds which fail to drop their moisture." The cause and effect implied in this statement are still by no means proved beyond doubt and is best omitted from a book meant for the general reader. Two minor printing errors, noticed were *Magnifera indica* for *Mangifera indica* (p. 140), and *Acacia lencophlœa* for *Acacia leucophlœa* (p. 113).

The special value of a book such as Sir Harold's—written with the authority and perspective of many year's first-hand knowledge—is this. Land reclamation costs money. Thus, the cost of soil conservation in the northern Punjab districts alone is estimated by Sir Harold Glover to be about Rs. 53 lakhs a year for 15 years. The soil specialist of course knows that the expenditure of these large sums of money is not only good investment but is the bare minimum insurance against the total loss of the essential capital of the rural community—the soil. For the success of anti-erosion measures, it is indispensable that Mr. Average Citizen be convinced of this for, as Sir J. D. Penny observes in his foreword, "..... in the last resort the success or failure of soil conservation measures will depend on the extent to which they enlist the assistance both of nature and of the humble tiller of the soil and the still humbler shepherd and goat-herd". In the absence of knowledge of the facts of the problem neither the money required nor the requisite co-operation of the villager would be forthcoming. Sir Harold Glover's book should be of great help—quite apart from its value as an objective record of valuable soil reclamation work in the Punjab—in opening the eyes of a complacent public to the menace of soil erosion in the Punjab and in convincing an even wider public that erosion is a deadly but curable disease.

The Exodus from Travancore to Malabar Jungels. Surveys by K. G. Sivaswamy and six Doctors. (Servindia Kerala Relief Centre, R.S. Puram Post, Coimbatore), August 1945. Pp. 39 + iv. Re. 1.

Unable to bear the privations in their native homes in Travancore brought about by famine, 15,000 settlers travelled long distances to the hilly parts of Malabar which have remained uncultivated for centuries. Migration was preferred as being the lesser of two evils; partial starvation at home or cultivation in malarial tracts infested with wild animals. The heroic struggles of these settlers against malaria and wild animals are described in this pamphlet. Medical and nutritional surveys, carried out with considerable difficulty, are also included. About 2,000 of the settlers died of malaria and malnutrition while some returned home broken in health and fortune. Many among the re-

maining are dragging on a miserable existence, with impaired vitality and heavily indebted to money-lenders. An appeal is made for effective and immediate relief, especially an unlimited supply of anti-malarial drugs. Anti-malarial operations, like aeroplanes spraying with insecticides, are also suggested.

Regarding the etiology of certain diseases in these settlers, it is wished that the authors have made less audacious statements. "Rice firmentation (fermentation) and these organisms may be a prominent cause of cirrhosis of the liver" (p. 15); "Want of animal protein in the diet also increases anæmia and particularly nervous diseases" (p. 16); "Their eating preserved foods of the previous night may have some relation to choleraic diarrhœa" (p. 32). These statements appear all the more glaring when one considers the caution exercised about tapeworm, a disease "attributed to the eating of dead cattle. This requires medical investigation" (p. 18). The expression "nitrogenous proteins" is rather revolting. Except for these minor blemishes, the book is an admirable document containing much material painstakingly collected. The book is priced too high. S. RANGANATHAN.

Report of the Scientific Advisory Board for the Year 1st January to December 1944. Issued under the authority of the Governing Body, Indian Research Fund Association, New Delhi. (The Secretary, Governing Body, Indian Research Fund Association, Secretariat, New Delhi.) Pp. 188. Re. 1.

The Annual Report of the Scientific Advisory Board for 1944 records another year of successful research despite the handicaps imposed by war conditions. Reports of the Advisory Committees on Cholera, Malaria, Nutrition and Plague are also incorporated. Work on the treatment of cholera with sulphaguanidine, and the statistical evaluation of the degree of protection conferred by anticholera inoculation form the principal researches under cholera. Results of detailed studies in the prevention and control of malaria, and large-scale field trials with various insecticides (including D.D.T.) and mosquito repellents are included. The comparative value of different sulpha drugs in the treatment of plague and the peculiar mode of spread of plague in certain rural areas in the Madras Presidency were investigated.

A good number of the researches financed by the I.R.F.A. are concerned with nutrition; 16 out of 42 enquiries relate directly to nutrition while a few of the schemes under "Other Researches" have an indirect bearng on nutrition. It is not surprising, therefore, that the bulk of the Report is devoted to this subject. A document of 18 pages dealing with the practical and public health aspects of nutrition, prepared for the benefit of the Public Health Committee of the Health Survey and Development Committee of the Government of India is also included. The findings of the Sub-Committee on "Nutritional Requirements" form a useful addition as also those of the Soyabean Sub-Committee. The latter conclude that "the nutritive value of soyabean, in comparison with that of other common Indian pulses is not such as to justify, from the standpoint of human nutrition, the immediate encouragement of the production and consumption of soyabean on a wide scale in India." The budget allotments for the various enquiries and staff of the I.R.F.A. and for the publication of the *Indian Journal of Medical Research* appear towards the end of the Report.

Those interested in the progress of medical research in India will find the Report useful and informative. S. RANGANATHAN.

The Indian Cotton Textile Industry 1944 Annual. (Published by Messrs. Gandhi & Co., Publishers, Jan Mansion, Sir Pheroz Shah Mehta Road, Bombay), June 1945. Pp. 150. Price Rs. 5.

The Annual represents a valuable contribution to the knowledge and objective study of the Cotton Textile Industry of this country. In layout and format, it closely follows its predecessors.

As usual the volume reviews the major domestic events in the industry and gives a wealth of valuable statistical data intelligently presented and takes the reader through the long and eventful history of the industry with remarkable brevity. Accurate and exhaustive statistical data plays an important role in all economic and industrial planning and in this aspect Mr. Gandhi's contribution is indeed praiseworthy.

The book reproduces some of the more important Textile Control Orders and also gives an exhaustive list of other control orders affecting the industry, which lends to the volume special topical interest. It presents in a lucid manner a brief history of the evolution of the Textile Control touching all its important aspects, the intricate problems it has had to face particularly of distribution and how they had to be tackled and solved. The book also publishes the recent Textile Industry (Control of Production) Order and explains its purpose and benefits. While all may not agree with the editor about the benefits of the scheme to the industry, there can be no doubt that it is an admirable emergency measure which has helped to relieve the present cloth famine in the country. The author's detailed survey of post-war problems facing the industry is of special interest, particularly his reference to the considered views expressed by the Chairman of the Bombay Millowners' Association on the obligations of the mills and the Government to the industry if it is to stand on a sure foundation to withstand the foreign competition.

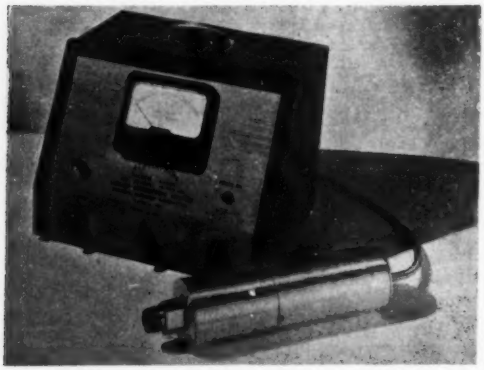
The volume annexes at the end two appendices, one dealing with the subject of cotton cultivation, its development and problems and another with the handloom industry and its potentialities during the post-war period supported by fresh extracts from the Report of the Fact Finding Committee (Handlooms and Mills) released in 1943.

On the whole the book is very interesting and informative and should be particularly useful in the field of post-war planning.

B. G. R.

SCIENCE NOTES AND NEWS

The Alphatron is an all-metal ionization gauge with continuous linear response to 10 mm. total pressure. The ionizing agent is a stream of Alpha particles emitted by a radioactive source, which permits operation at any pressure, including atmospheric, without damage to the gauge. The steady emission



characteristic of the radioactive element and advanced amplifier design insure great stability and reduce needle flicker to a minimum. The model produced at present by the National Research Corporation in Boston covers from 0 to 10 mm. in three ranges, all reading direct pressure. The ranges are 0 to ·1 mm., 0 to 1 mm., and 0 to 10 mm. Pressures can be read to one per cent. of full scale reading in each case. The gauge is ideal for measuring pressures of gases other than air, such as argon, water vapour and hydrogen, as the linear response of the gauge holds true regardless of the atmosphere.

The Eleventh Annual Meeting of the Indian Academy of Sciences will be held at Udaipur from 26th December to 28th at the invitation of the Government of Mewar. The National Academy of Sciences is holding its annual meeting jointly with the Indian Academy.

The Sir C. R. Reddy National Prize has been awarded by H. E. the Governor, Chancellor of the Andhra University, to Prof. C. V. Chandrasekharan working at the Yerkes Observatory in America.

Sir C. P. Ramaswami Aiyar, Dewan of Travancore, will address the annual Convocation of the Patna University scheduled to be held on November 24th, 1945.

The Convocation of the Annamalai University will be held on 27th November 1945; Sir Norman Strathie, Adviser to H. E. the Governor of Madras, will address the Session.

Sir Mirza M. Ismail has accepted the invitation of the authorities of the Benares Hindu University to deliver the Convocation Address on 2nd December 1945.

Mr. K. M. Pannikar, Prime Minister, Bikanir, has been invited to deliver the Convocation Address of the Andhra University on 6th December 1945.

Sir C. R. Reddy has kindly consented to address the Convocation of the Utkal University scheduled to be held on the 12th December 1945.

In connection with the forthcoming Session of the Indian Science Congress to be held in Bangalore from the 2nd January to 8th January 1946, the Local Committee has decided to bring out a Souvenir in an attractive form with suitable illustrations. About 2,000 copies will be printed and distribtued amongst the delegates. Those intending to insert an advertisement in the Souvenir are invited to correspond with Mr. B. R. Subba Rao, M.A., Dip.-in-com., Convener, Publication Sub-Committee, Indian Science Congress Session 1946, Central College, Bangalore.

The 33rd Session of the Indian Science Congress will be held in Bangalore from the 2nd to the 8th January 1946. The problem of accommodation in Bangalore being very acute, the Local Secretaries advise that arrangements should be made well in advance in the different hotels and students' hostels. Bangalore during January is comparatively cold; the delegates are advised to provide themselves with warm clothing. There will be full-day excursions (if sufficient number of delegates participate) to Iron and Steel Works and Paper Mills at Bhadravati, the famous Jog Falls, Belur and Halebid Temples, Mysore, Krishnarajasagara, Seringapatam, Sivasamudram Hydro-Electric Works, and Kolar Gold Fields.

Numerous students and scientists, who have been benefited by the brilliant researches of Rai Bahadur Dr. S. L. Hora, met in Calcutta recently and decided to celebrate the Silver Jubilee of his first scientific publication (September 1920). For celebrating the occasion a comprehensive programme is being chalked out but its successful execution will largely depend upon the funds that could be collected for the purpose. Those wishing to associate themselves with this function are invited to remit their donations to Dr. Nazir Ahmad, Hon. Secretary, Jubilee Committee, 13, Ballygunge Circular Road, Calcutta.

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